Final Report
on
Sonoran Pronghorn Status
in Arizona

Prepared by
Arizona Game and Fish Department
Rebecca L. Wright, Wildlife Assistant
James C. deVos, Jr., Field Contracts Administrator
Special Services Division
2222 West Greenway Road
Phoenix, Arizona 85032-4399

Contract No. F0260483MS143

October 1986

Table of Contents

Tables

Figures

Appendices

STATUS SUMMARY

Taxon Name:	*Antilocapra americana sonoriensis* (Goldman)
Common Name:	Sonoran pronghorn antelope
Family:	Antilocapridae
Order:	Artiodactyla
Counties and States Where Located:	Yuma, Pima, and Maricopa Counties, Arizona Sonora, Mexico
Current International Status:	Code of Federal Regulations, Title 50, Chapter 1 USFWS Subpart C § 23.23, Appendix 1, October 1, 1984, p235, listed 7-1-75.
Current Federal Status:	USFWS Endangered & Threatened Wildlife & Plants, July 27, 1983, page 8. 50CFR 17.11 & 17.12. Endangered, listed March 11, 1967.

Current State Status: Threatened Native Wildlife in Arizona, Arizona Game and Fish Commission December 10, 1982, page 12. Group 3 (continued presence in Arizona could be in jeopardy in the foreseeable future).

I. INTRODUCTION

Pronghorn antelope (Antilocapra americana) are found only in North America, with five subspecies currently recognized: Antilocapra americana americana, A. a. mexicana, A. a. oregona, A. a. peninsularis, and A. a. sonoriensis. The latter subspecies is found in the Sonoran desert of southwestern Arizona and western Sonora, Mexico. Due in part to its geographical isolation in one of the harshest environments in the United States and Mexico, little is known about the smallest of the North American pronghorn. A few notes and results of several surveys have appeared in the literature over the last 60 years. Two studies were conducted by the Arizona Game and Fish Department, one in 1968 (Carr 1969) and one in 1980 (AGFD 1981). Both studies concluded that more extensive fieldwork was necessary for taxonomic clarification and to provide data for management of Sonoran pronghorn.

Four participants funded this current study - the U.S. Fish and Wildlife Service (USFWS), Arizona Game and Fish Department (AGFD), Shikar Safari, and the U.S. Department of Defense (Air Force). Field data were collected by AGFD employees, with occasional assistance from personnel of the Cabeza Prieta National Wildlife Refuge (CPNWR) and Organ Pipe Cactus National Monument (OPCNM). This report covers the period from October 1983 to October 1985.

A. Classification

An adult doe Sonoran pronghorn was collected by Vernon Bailey and Frederick Winthrop on December 11, 1932 approximately 64 km north of the Costa Rica ranch, on the north side of the Rio de Sonora and southwest of Hermosillo, Sonora, Mexico (Goldman 1945). It was placed in the U.S. Biological Survey collection (original #11291). E.A. Goldman (1945) named and described the specimen as Antilocapra americana sonoriensis, a previously undescribed race of pronghorn from the desert region of central western Sonora. At the time, he also examined a specimen of a doe from Fort Buchanan (now Crittenden), Santa Cruz County, Arizona, and referred to it as A. a. sonoriensis. This specimen is now believed to be an intermediate between sonoriensis and mexicana, exhibiting cranial features of both subspecies (Paradiso and Nowak 1971). Until 1969, these were the only specimens reported in the literature.

On February 1, 1969, four buck Sonoran pronghorn (one adult, three juvenile) were killed illegally near Caborca, Mexico, and smuggled to Tucson for mounting. The four skulls, minus skins, were seized by U.S. Game Management Agents of the USFWS and deposited in the National Museum of Natural History (U.S.N.M. #347452-347455). The skulls show similarities to the holotype for sonoriensis and exhibit differences from the other four subspecies (as does the holotype), lending support to the continued recognition of sonoriensis as a valid subspecies of Antilocapra americana. Between 1970 and 1975, three other

specimens were found within the Sonoran pronghorn range (AGFD 1981). On June 24, 1970, a dead buck fawn was removed from the Wellton-Mohawk Canal south of Interstate 8; on July 10, 1972, the carcass of an adult buck was found along Ajo Mountain Drive (east of Highway 85) and, in September 1975, an adult doe was hit by an automobile and killed on Highway 2, 8 km west of Sonoyta, Mexico. There is no mention in the literature of any comparative data on these specimens, although the road-kill doe is in the University of Arizona mammal collection. Three collared Sonoran pronghorn (one buck, two does) were lost to various causes during the present study and have been submitted to the USFWS Museum of Natural History for taxonomic classification.

B. Taxonomic Description

A. a. sonoriensis differs from the other four subspecies in size, color and cranial structure (Paradiso and Nowak 1971). Sonoran pronghorn are somewhat smaller and paler, and the cranium is distinctive from the other subspecies. Molar teeth are shorter and narrower, the rostrum is more slender and the mastoidal breadth and greatest width at the posterior border of the orbits are less. The skull is narrower and more delicately structured. The frontal depression is less pronounced and the auditory bullae are smaller, flatter and project less below the level of the basioccipital. The premaxilla are less extended posteriorly along the median line. In all but three of 54 mexicana, americana, and peninsularis skulls examined by Paradiso

and Nowak (1971), depression of the palate posterior to the palatine foramine is bordered on both sides by a high and sharp ridge that extends from the anterior edge of the alveolous of the first premolar to the anterior tip of the maxilla. This ridge is lacking in the Sonoran pronghorn skulls, except in the region immediately anterior to the alveolus of the first premolar. A comparison of the four subspecies skull measurements are found in Table 1.

The skull description for sonoriensis (Goldman 1945) was based on the type specimen collected in Sonora, Mexico. The doe skull collected from Crittenden, Arizona, seems to be intermediate between sonoriensis and mexicana in some characteristics (Paradiso and Nowak 1971). The mastoidal region is narrow, the frontal depression is poorly developed and the bullae are small, all characteristic of sonoriensis, yet the skull is broad across the orbits and the molar teeth are large, as found in the mexicana subspecies. The three juvenile buck skulls from Caborca are narrower than skulls of comparative age from the other four subspecies, and differ in the same characteristics as the adult buck from Caborca.

Based on the six skulls (two does [1945] and four bucks [1969]), sonoriensis was thought to be more distinctive from the other four subspecies than they were from each other (Paradiso and Nowak 1971). However, in the 1981 special report by the Arizona Game and Fish Department, recognition of the subspecies designation of sonoriensis is questioned. The authors examined the four buck skulls and concluded that the measurements (as well

Table 1. Cranial measurements of four subspecies of Antilocapra americana. Mean is followed by range (in parenthesis); N = number in sample; SD = standard deviation. From Paradiso and Nowak 1971.

Subspecies	Males Mean(range) (mm)	N	SD	Females Mean(range) (mm)	N	SD
			Greatest length			
A. a. sonoriensis	281.0			250.8,-----		
A. a. americana	284.2(278.3-197.0)	13	4.68	281.1(268.3-294.0)	6	8.37
A. a. mexicana	276.0,294.0			274.0(268.4-289.0)	5	7.96
A. a. peninsularis	285.1(274.0-298.0)	7	6.64	270.3(261.0-288.0)	6	9.05
			Basilar length			
A. a. sonoriensis	243.2			219.3,-----		
A. a. americana	248.8(243.0-257.9)	12	4.15	246.6(238.5-257.8)	6	6.48
A. a. mexicana	239.4,254.2			239.2(232.1-250.4)	5	6.61
A. a. peninsularis	247.2(238.0-260.1)	7	6.26	238.2(231.5-250.5)	6	6.55
			Occipitonasal length			
A. a. sonoriensis	221.8			192.0,208.3		
A. a. americana	224.0(215.2-237.5)	13	6.62	221.9(209.9-232.2)	5	8.21
A. a. mexicana	220.5,234.2			215.7(207.8-221.2)	6	6.64
A. a. peninsularis	224.9(213.1-235.3)	7	7.54	211.4(199.5-230.5)	6	9.67
			Length of maxillary toothrow			
A. a. sonoriensis	72.0			67.0,68.1		
A. a. americana	73.1(67.0-80.4)	15	2.77	72.1(68.8-75.0)	7	1.91
A. a. mexicana	72.1,71.7,68.7			70.2(67.7-72.2)	6	1.41
A. a. peninsularis	73.6(70.8-80.0)	7	2.98	70.0(65.5-73.0)	6	2.67
			Alveolar length of M3			
A. a. sonoriensis	16.6			15.5,18.3		
A. a. americana	18.6(16.4-22.0)	15	1.67	20.1(16.6-23.5)	7	2.27
A. a. mexicana	17.8,19.3,19.5			17.6(16.0-19.3)	6	1.44
A. a. peninsularis	18.3(15.1-19.9)	7	1.47	17.9(16.3-20.6)	6	1.58
			Breadth of rostrum across M2			
A. a. sonoriensis	65.7			66.7,66.2		
A. a. americana	71.9(67.0-75.7)	14	2.74	71.0(67.0-78.3)	7	3.39
A. a. mexicana	67.0,69.7,72.0			70.0(64.5-71.4)	6	2.44
A. a. peninsularis	69.8(65.2-73.3)	7	2.53	66.5(65.0-67.7)	6	.94
			Mastoidal breadth			
A. a. sonoriensis	77.5			69.2,70.2		
A. a. americana	83.6(77.2-87.9)	14	2.86	75.9(72.5-78.7)	5	2.37
A. a. mexicana	85.2,88.0			74.6(71.7-77.3)	6	1.97
A. a. peninsularis	81.7(80.0-83.2)	7	.98	74.8(72.3-77.8)	6	1.63

as the type specimen and Crittenden doe measurements) all fell within the range of values given for other subspecies by Paradiso and Nowak (1971). They conclude that the subspecies classification was unwarranted at that time but agreed further study, both physiological and behavioral, would further clarify the situation. All six cranial measurements fall in the lower end of the ranges; a continued clustering of sonoriensis measurements in the lower ranges could indicate subspecies status is warranted.

C. Biogeographical Location

The range of the Sonoran pronghorn is the plains of central western Sonora, Mexico and north to southwestern Arizona. The historical range is difficult to determine since the subspecies was not described until 1945, many years after the population had declined and marginal populations were extirpated (AGFD 1981). Historically, they are thought to have ranged from Hermosillo to Kino Bay to the south; Highway 15, Mexico to the east; Altar Valley and the Papago Indian Reservation to the north; and Imperial Valley, California, to the west (Fig. 1). During an international boundary survey from 1892-1894, Sonoran pronghorn were seen in every open valley from Nogales, Mexico, to Yuma, Arizona (Carr 1971). Ajo Valley supported a large population and Sonoran pronghorn were frequently seen along the Camino del Diablo. Wallace (1965 as noted in Carr 1971) stated that Raphael Pumpelly saw Sonoran pronghorn in Altar Valley, Arizona. None

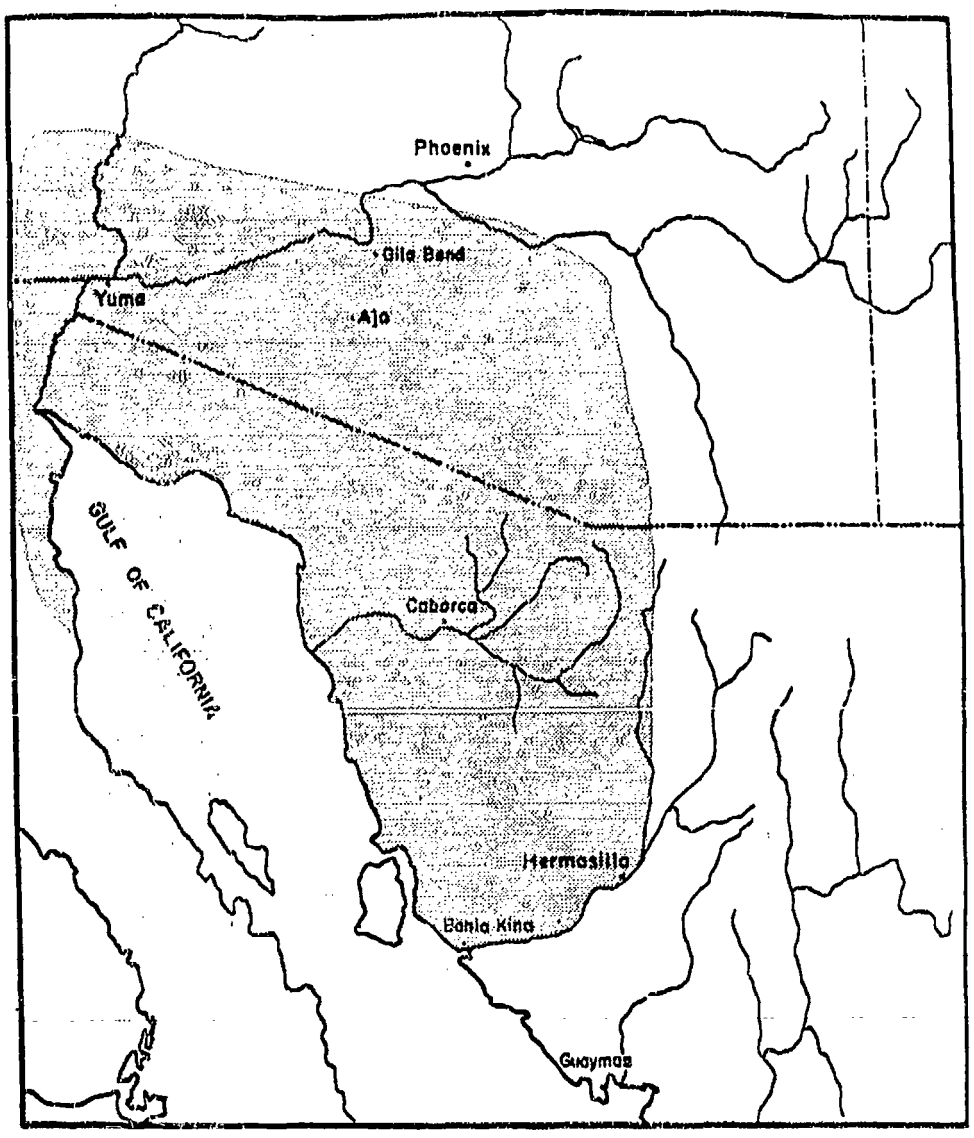


Figure 1. Historic distribution of Sonoran pronghorn in Arizona and Sonora, Mexico.

have been observed there since 1933, and the Indians living on the slopes of the Baboquivari Mountains are thought to be responsible for the Sonoran pronghorn's disappearance (Arrington 1942 in Carr 1971). In 1907, Hornaday undertook his Pinacate Expedition and saw Sonoran pronghorn in the Cierro Colorado area of the Pinacate Region at the south end of MacDougall Pass and on the Pinacate Lava Flow. His expedition collected several specimens.

Presently, Sonoran pronghorn range south to Caborca; east to Mexico Highway 15 and Arizona Highway 85; north to U.S. Interstate Highway 8 and west to the Lechuguilla Desert (Fig. 2). Only one sighting, in 1976, has occurred north of Interstate 8 in recent years (AGFD 1981) supporting the belief that the highway is a barrier to movement to the north. No sightings of Sonoran pronghorn have been recorded on the Papago Indian Reservation for 15 years. Once ideal habitat for the Sonoran pronghorn, unlimited Indian hunting and excessive grazing have decreased population numbers and degraded the habitat until the reservation could not support a resident pronghorn population (Carr 1971, AGFD 1981).

Sonoran pronghorn use patterns have changed since 1971. Carr (1972) noted that the pronghorn were frequently seen in the Pinta Sands area and rarely seen in the Cameron Tanks area, the Growler Valley between the Granite Mountains and the Growler Mountains, in Mohawk Valley between the Sierra Pinta Mountains and Bryan Mountains, in the San Cristobal Valley between the Granite Mountains and Mohawk Mountains, and were infrequently seen on Luke Air Force Base Gunnery Range (LAFBGR). Present-day

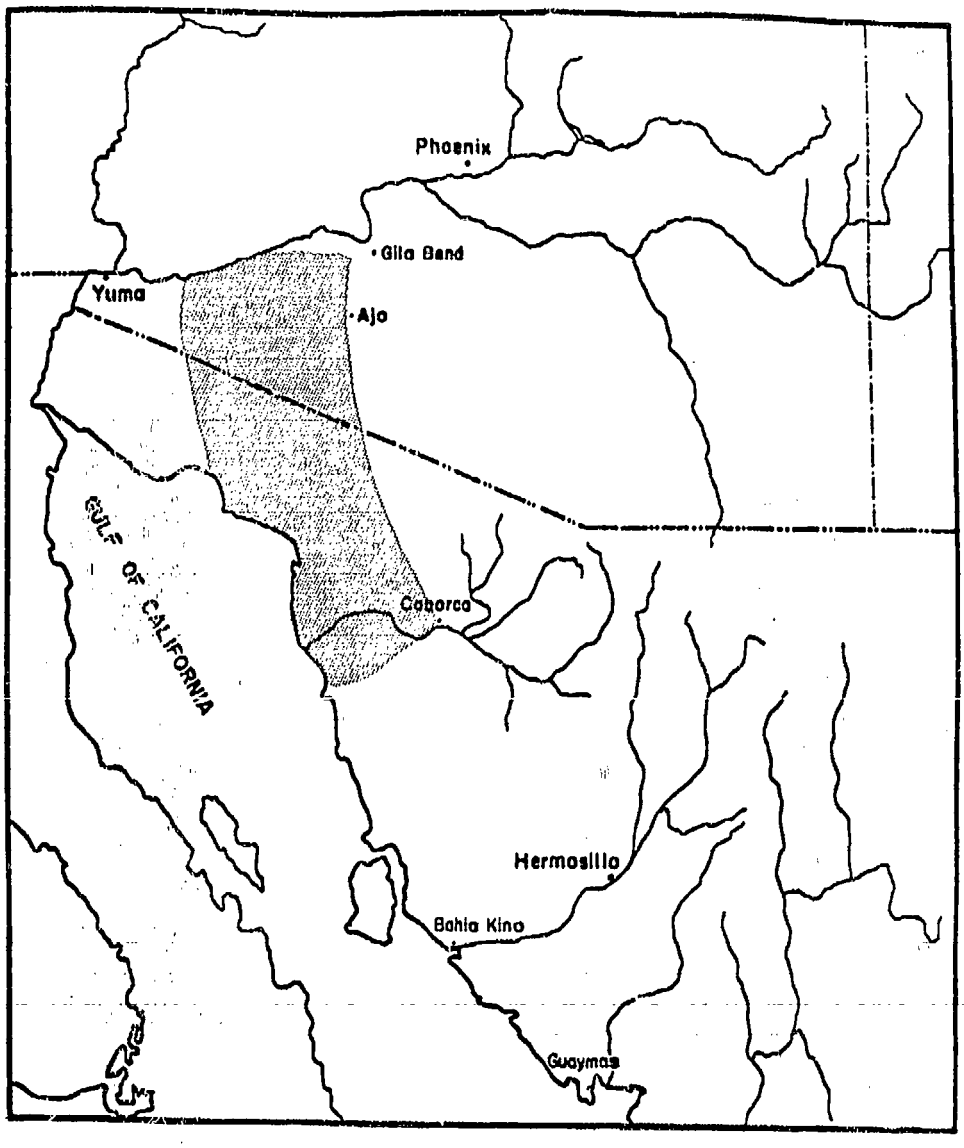


Figure 2. Present distribution of Sonoran pronghorn in Arizona and Sonora, Mexico.

sightings in the Growler Valley are very frequent, and Mohawk Valley, San Cristobal Valley and LAFBGR all support bands of 10-20 animals during most of the year. A band of seven to ten Sonoran pronghorn has been regularly observed in the Cameron Tanks area.

In Mexico, Sonoran pronghorn range south to Puerto de Lobos. They are frequently sighted on or near the Pinacate Lava Flow or in the open valley between the lava flow and Caborca. A few bands apparently cross the border, but there is no apparent long-range movement or "replenishing" of the Arizona population by the Mexican population, as was previously believed.

D. Population Estimates

The first population estimate for Sonoran pronghorn was made in 1924 (Nelson 1925). Ben Tinker of the Wildlife Protection Fund supplied the USDA with the distribution of pronghorn of Sonora in a 1925 status report. He counted a total of 595 Sonoran pronghorn in 4 areas in Sonora, and estimated 105 in Arizona (Carr 1969). Nichol (1941) estimated 60 in southwest Arizona (not including OPCNM) in 1941; Villa (1958) estimated 1000 in northwest Sonora in 1957, while Halloran estimated less than 100 in Arizona during the previous year. Monson (1968) estimated the Arizona population to be less than 50, but Carr's ground observations (1968-1974) placed the number from 50 to 150. This increase is probably the result of increased effort in observing pronghorn.

Currently, it is estimated that there are 33-93 Sonoran pronghorn in Mexico (Gonzales-Romero and La Fon Terrazas 1985). Results of the present study indicate there are 85-100 in Arizona.

E. Reasons for Population Decline

Several factors contributed to the decline in numbers of the Sonoran pronghorn over the last century. During the late 1800s, farming and irrigation practices and town development along the Gila River and Rio Sonoyta drained the free flowing water, creating intermittent, and often dry, riverbeds (Carr 1972). Cattle ranching was initiated on the game range area, OPCNM and LAFBGR, with livestock numbering several thousand at its peak. Drying of the area, coupled with the reduction of vegetation by cattle grazing, caused degradation of the quality of habitat available to the Sonoran pronghorn. Cattle also may have competed with pronghorn for available water. By the early 1980s, all cattle had been removed from the pronghorn's range. Ranching still occurs in Sonora, where poor range conditions prompted a Sonora resident to report of malnourished Sonoran pronghorn found dead (Carr 1972). Overall, poor range conditions still appear to be the leading cause in the decline in Sonoran pronghorn numbers.

Hunting was also prevalent until the 1920s, when it was outlawed. In Arizona, poaching continued but was not viewed as a problem, especially when the majority of the Sonoran pronghorn's range was converted to a game range, national monument and

military range between 1937 and 1941. This reduced access to areas frequented by Sonoran pronghorn. However, poaching in Mexico still occurs despite being unlawful since 1922. It is difficult to administer protection for the Sonoran pronghorn in this region. The development of the Mexican citizen conservation group, Pronatura para la Protection y Approvectiamiento de la Fauna en el Estado de Sonora, helped decrease the incidence of poaching in Sonora in the 15 years prior to 1971, yet poaching still remains a limiting factor for the Sonoran pronghorn in Mexico (Carr 1971). On July 22, 1984, seven Sonoran pronghorn were reported poached 75 km southwest of Sonoyta.

F. Past Management Practices

Protection of the Sonoran pronghorn in the United States was instigated in 1923, when a special game warden was employed to protect the Sonoran pronghorn and sheep along the Sonora/Arizona border (the pronghorn that crossed the border at this time were protected under the Permanent Wildlife Protection Fund) (Carr 1971). His main duty was to patrol for poachers.

Past management practices have mainly been custodial in nature, since the range is divided into three areas controlled by three different agencies. The CPNWR has reduced human access and, therefore, reduced possible human impacts in crucial Sonoran pronghorn habitat. The refuge has also maintained, as well as developed, water holes for Sonoran pronghorn and bighorn sheep. Approximately 95 percent of OPCNM has been a wilderness area

since 1978, limiting access to the area. Several wells have also been maintained. LAFBGR and CPNWR have greatly reduced public access. AGFD has access to maintain catchments in the tactical ranges.

Protection of crucial habitat for the past 45 years has been an important factor in maintaining Sonoran pronghorn numbers but equally important was the removal of cattle from CPNWR and OPCNM through the early 1980s. Continued maintenance and development of accessible water has probably also benefited the Sonoran pronghorn. In Arizona, the Sonoran pronghorn population has neither increased nor decreased significantly since the 1924 survey conducted by Nelson, yet the dramatic decrease in the half century prior to that survey (due to several factors primary of which is habitat destruction) warranted the inclusion of the Sonoran pronghorn on the Endangered Species list on March 11, 1967 (USFWS 1983).

Studies were conducted from 1968 to 1972 by the AGFD to determine population numbers, life history and habitat use, and were instrumental in bringing the management problems of the Sonoran pronghorn to the attention of the land managing agencies. In 1982, the Sonoran Pronghorn Recovery team drafted the Sonoran Pronghorn Recovery Plan, proposing ways to maintain existing population numbers and distribution, and developing techniques to increase the U.S. population to 300 animals (an average over a 5-year period) or a number that is feasible for

the habitat. When the appropriate number is reached and major threats have been reduced or eliminated, the Sonoran pronghorn would be considered for delisting.

II. STUDY AREA DESCRIPTION

In Arizona, the Sonoran pronghorn range is approximately 1 million hectares (ha) in the lower southwest corner of the state. The study area covers from Interstate 8 on the north, Highway 85 on the east, the International Boundary on the south and the Lechuguilla Desert to the west (Figure 3). This area is principally managed by three agencies (Figure 4): the U.S. Fish and Wildlife Service (CPNWR), the U.S. National Park Service, (OPCNM) and the U.S. Air Force (LAFBGR).

CPNWR covers 348,000 ha from the Little Ajo Mountains to the Cabeza Prieta Mountains, and from Childs Valley to the International Boundary. Ranching and mining were common during the first 40 years of the century, and the Camino del Diablo (Road of the Devil) was a frequently traveled thoroughfare from Caborca to Yuma. In 1939, the Cabeza Prieta Game Range was created by the Department of Interior. Travel was limited to administrative roads, hunting and collecting were prohibited, and cattle were removed from a major portion of the refuge. In 1978, when the area was designated a national wildlife refuge, many cattle were removed. Currently, access to the refuge is by permit only and hunting is restricted to a limited number of

Figure 3. Sonoran pronghorn study area, southwestern Arizona.

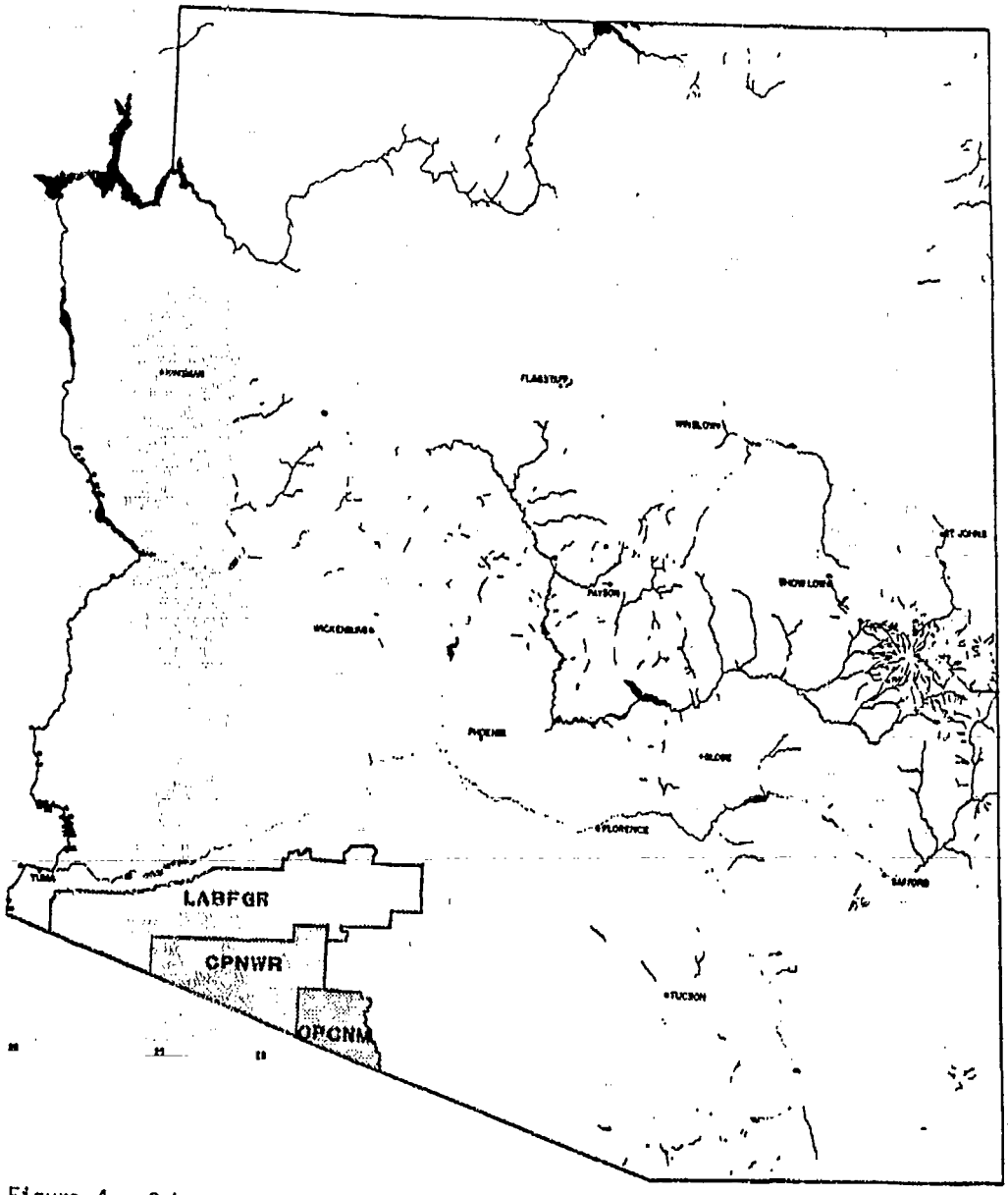


Figure 4. Cabeza Prieta National Wildlife Refuge, Organ Pipe Cactus National Monument and Luke Air Force Base Gunnery Range in southwestern Arizona.

bighorn sheep permits per year. Vehicular travel is confined to a few visitor and administrative roads. There are approximately 23 tanks, wells, catchments, and tinajas (natural water holes) maintained or monitored for wildlife (Steve Van Riper, pers. comm.) and redevelopment of other closed wells is proposed. Visitor use is low, with only 1,000 visitors per year.

OPCNM is a Sonoran desert preserve covering 134,000 ha south of Ajo, and is bordered by Mexico, the Papago Indian Reservation, CPNWR and Bureau of Land Management (BLM) lands. The monument was established in April 1937 by Presidential Proclamation which prohibited the extension of mining activity within the boundaries of the unit until 1941. From 1941 to 1976 mining was again permitted by an Act of Congress. By another congressional action in September, 1976 mining was again prohibited, a state which has lasted to the present time. From long before the establishment of the Monument, grazing of livestock was a major impact. Permits to graze cattle were held by the Sand Papago and the Gray brothers. The former permit was relinquished in 1946, the latter in 1969. Cattle grazed in trespass until 1978 when all cattle and burros were removed. Vehicular access is minimal throughout the Monument and no hunting, camping or collecting is permitted (camping is allowed in established campgrounds).

LAFBGR was established in 1941, when 1.1 million ha (including CPNWR) were set aside for military maneuvers (Natural Resource Planning Team, UofA 1984). The range is bordered by Interstate 8 to the north, the Gila Mountains to the west, Mexico to the south, and is bordered along a southwest to northeast line

by OPCNM and the Papago Indian Reservation. The western sector is administered by the U.S. Marine Corps in Yuma, Arizona, and the eastern sector is administered by the Gila Bend Sector of the Air Force. Within the sectors, there are maneuvering ranges with air-to-ground weapons delivery, tactical air command ranges with target complexes of tanks and convoys, and air-to-air ranges utilizing pilotless drones and towed targets. Mock duels and computer-analyzed flight maneuvering, as well as some major weapons testing in remote areas, occur during part of the year. Public access has been greatly reduced (limited hunting is allowed during the fall) and, since most maneuvers are performed from the air, there is little disturbance to the ground. Air-to-ground ordinance, as well as air-to-air ordinance, causes slight damage upon impact and jettisoned 5 m high aluminum targets are embedded across the desert. Every five years the ordinance crews clear the areas of live ordinance, leaving some tracks on the desert pavement. Despite these impacts, LAFBGR remains one of the southwest's most unspoiled desert regions.

A. Physiography, Geology, and Soils

The regional topography typifies that of the Basin and Range physiographic province of the western and southwestern U.S. and northern Mexico (Nations and Stump 1981). The mountains of the area are large-scale block faulted mountains that created ridges separated by wide alluvial valleys. These valleys are partially filled with clay, silt, and alluvium deposited from sheet erosion

and ephemeral streams. Two types of mountains are found in the region: a sierra type composed of metamorphic rock and granitic material, and a mesa type composed of igneous basalt. The sierra type mountains are extremely narrow, sharp crested, and steep sided, arising abruptly with limited foothills (i.e. the Sierra Pinta and Granite Mountains). The mesa type mountains are also steep sided and rise sharply, but are flat on top and are less rugged (i.e. the Growler Mountains). Alluvial material was transported from the sides of the mountains down canyons, where the material fans out into the valleys from the base of the mountains forming "bajadas". All mountain ranges in the region (except the Bates and Agua Dulces Mountains) run northwest to southeast, and none except the Little Ajo Mountains are higher than 915 m. Mean elevation is from 122 m at the northwest end of the Mohawk Mountains to 550m in the Ajo Valley.

The valleys are fairly level, with drainage to the north and west through a braided wash system in the center of the valleys. On OPCNM, approximately 35% of the rainfall drains to the south into the Rio Sonoyta (NPS 1977). Most of the moisture that falls on the study area is absorbed, with washes running only at the peak of monsoon activity in the late summer. Several drainage systems are enclosed systems that occasionally fill with water only a few inches deep. These systems at one time were lakes. Evaporation of water and drying of the mud has created beds of hard packed soil. These "playas" produce a carpet of annual forbs after summer rains. Pinta Playa and Dos Playas on the CPNWR are examples.

A large lava flow crosses north into the Tule Desert from the Pinacate Peaks (elevation 1291 m) in Mexico. The flow covers approximately 32 km^2 in Arizona. Erosion has created pockets of sandy soil that support vegetative areas of paloverde, mesquite, and ephemerals.

Soil types range from sandy loams to coarse, clean sand. Several sand areas, remnants of marine coasts, are found in the central region of the study area. Large sand dunes are found west of the Mohawk Mountains, west of the Aguila Mountains and south of the Sierra Pinta Mountains. These plains have long been considered ideal Sonoran pronghorn habitat due to the similarity to habitats utilized in Mexico.

B. Climate

The Sonoran Desert climate is characterized by extreme heat and aridity. Summer temperatures (mid-May to mid-September) range from 38-44°C, with soil temperatures often reaching 75°C (AGFD 1981, Sellers and Hill 1974). The rest of the year, the temperature remains quite comfortable, ranging from 19-25°C. Freezing periods are infrequent in Ajo (elev. 537 m), with freezes starting December 16 and ending February 5. As elevation lowers to the west, freezing periods are more infrequent.

Sonoran pronghorn habitat is one of the driest areas in the southwest (Table 2). Average annual precipitation is 127 mm, falling mainly during the two rainy seasons. May and June are typically the driest months.

Table 2. Climatological summary of weather stations surrounding Sonoran pronghorn habitat in southwestern Arizona. From Sellers and Hill 1974.

	Temperature C° (mean)								Total Precipitation, mean millimeters			
	Daily Maximum				Daily Minimum							
	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
Ajo	17.9	28.1	39.9	31.3	5.0	13.2	26.0	16.5	17.8	8.4	34.5	13.0
OPCNM	19.6	28.9	39.6	31.5	3.0	9.5	23.2	13.1	19.3	5.7	34.5	17.3
Mohawk	20.8	32.3	44.2	34.4	5.5	22.9	35.7	25.0	8.4	7.6	12.2	4.3
Wellton	20.2	30.2	41.3	32.8	1.4	10.2	24.5	12.7	10.4	3.3	8.1	7.6

From July to September, deep currents of moisture moving across southern Arizona from the Gulf of Mexico and tropical air (from maritime hurricanes) traveling north through the Gulf of California cause quick local thunderstorms. This "monsoon" season causes unpredictable flash floods in the major washes, often cutting off access to various portions of the study area. These rains produce an abundance of annual forbs and grasses.

Winter precipitation (December to February) is a result of Pacific Ocean storms that cover southern California and Arizona. These storms are more widespread, less intense and longer lasting than the summer monsoons. Occasional snow flurries occur, but the snow generally melts before reaching the ground. Abundant spring annual and perennial vegetation and grass production result from these storms.

C. Vegetation

The Sonoran pronghorn are found in one of the most complex and diversified deserts in the United States, the Sonoran Desert (Brown 1982). The flora of this region tends to be a drought-adapted subtropical group of species and, due to the bimodel rainfall pattern, displays a greater diversity than surrounding deserts. Shreve and Wiggins (1951) recognize seven subdivisions in this desert; the study site is characterized by two of the subdivisions, the Arizona Upland subdivision (AU) and the Lower Colorado River Valley subdivision (LCRV).

The majority of the study site is classified as LCRV. This subdivision is characterized by high temperatures, low precipitation, and generally a single perennial plant species in open valleys, playas and dunes (Brown 1982). Trees and shrubs are scattered along drainage ways.

The most widespread and important community in the LCRV is the creosote (Larrea tridentata)-white bursage (Ambrosia dumosa) association (Brown 1982). Creosote is scattered throughout the valleys up onto the higher elevation bajadas. White bursage is found in association with creosote on the valley floors, but tends to thin out in the bajada regions. In sandier areas, big galleta (Hilaria rigida) and indigo bush (Psorothamnus schottii) appear. Creosote disappears completely in the sandy plain in north San Cristobal Valley where white bursage is the dominant species.

Along drainage ways, larger shrubs and trees are found. Trees that require a higher moisture content, blue paloverde (Cercidium floridum), mesquite (Prosopis juliflora) and ironwood (Olneya tesota), are commonly seen.

Other species represented and commonly found in the LCRV subdivision are the silver cholla (Opuntia wigginsii), teddy bear cholla (O. bigelovii), Engelmann hedgehog (Echinocereus engelmannii), and compass barrel cactus (Ferocactus acanthodes).

The Arizona Upland division is found along the eastern border of the study site. Although creosote and bursage are still found in this subdivision, the appearance of the vegetation is more like a scrubland of trees, scrubs and cacti. Blue

paloverde, ironwood, mesquite, and cat-claw acacia (Acacia greggii) are found in the lower regions, whereas foothill paloverde (Cercidium microphyllum) and crucifixion thorn (Holacantha emoryi) are found in the upper, northern regions. Mixed cacti are an important community in this subdivision; thornber buckhorn cholla (Opuntia acanthocarpa var. thornberi), staghorn cholla (O. versicolor), chain-fruit cholla (O. fulgida), teddy bear cholla, saguaro (Carnegiea giganteus), organ pipe (Stenocereus thurberi), and ocotillo (Fouquieria splendens) are common. The bajadas and low foothills are characterized by a paloverde/mixed-cacti scrub series of this subdivision.

D. Water Sources

Before the turn of the century, two rivers flowed in the Sonoran pronghorn's range; to the north was the Gila River, to the south (in Mexico) was the Rio Sonoyta (Carr 1972). Both were thought to be important watering areas for the Sonoran pronghorn, as well as providing large areas of forage for wildlife (Carr 1972). Development of the towns of Gila Bend and Sonoyta along the rivers led to large farming and ranching operations, ground water pumps and dams along the water courses. As a result, these rivers were dry for many years. Presently, the Rio Sonoyta runs intermittently and since 1977 the Gila has had surface water flows more frequently; increased rainfall has increased the incidence of flooding along the Gila flood plain.

Several natural springs are found within the Sonoran pronghorn's range. Quitobaquito Springs, in the Quitobaquito Hills in southwest OPCNM, was once a popular watering hole, not only for wildlife but for Indians, ranchers and travelers. Wildlife use of the springs is reduced as a result of public-use in the vicinity of the spring, including Highway 2 to the south. Williams Spring (found 1½ km north of Quitobaquito Spring in the Quitobaquito Hills), and Dripping Springs (in the Puerto Blanco Mountains) are also found on OPCNM. Baker Tanks is located on the valley floor 13 km southeast of Wellton between Baker Peaks and the Copper Mountains. It was once used by ranchers, Indians, and wildlife; construction of a picnic area adjacent to the tank has decreased its availability to the Sonoran pronghorn.

Scattered over the study area are 35 developed catchments, tanks, water holes, natural seeps, potholes, and tanks (Figure 5, Table 3). Approximately 20 water sources are available to the Sonoran pronghorn; the remainder are located in inaccessible areas in the mountains or are dry most of the year. On OPCNM, Sonoran pronghorn have been sighted near Pozo Nuevo Well, Bates Well, and Cipriano Well; tracks have been sighted near the AGFD water catchment on the west side of Aguila Mountains on the gunnery range. The majority of available watering sites are on the CPNWR. The USFWS maintains wells at Papago and Charlie Bell Wells (both abandoned ranches), Tule and Little Tule Wells, Jose Juan Tank, Jack's Well, Redtail Tank, the newly refurbished Adobe Windmill and a dozen other small, ephemeral tanks and potholes.

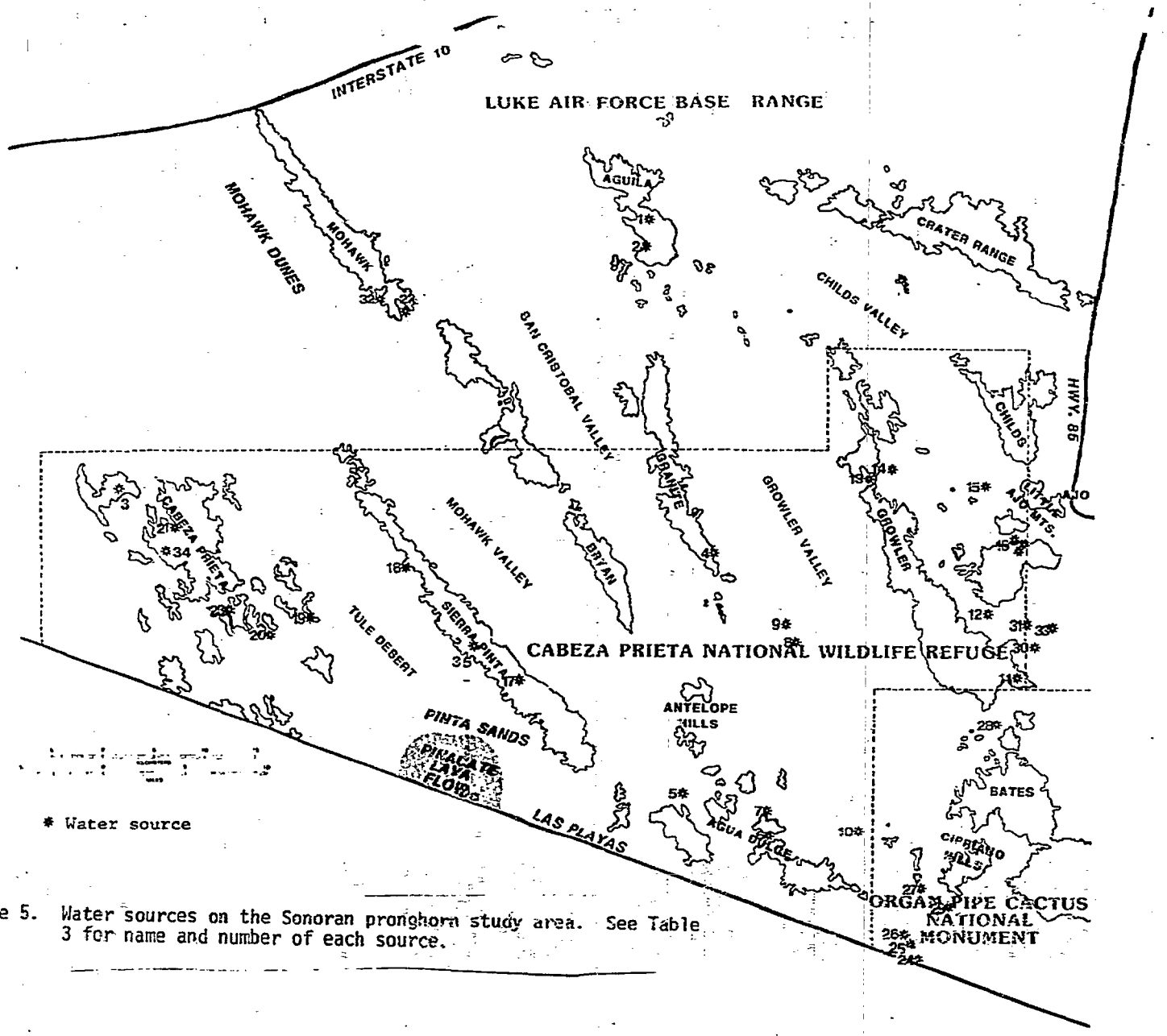


Figure 5. Water sources on the Sonoran pronghorn study area. See Table 3 for name and number of each source.

Table 3. Number, name, UTM coordinate and type of 33 water sources considered to be available to Sonoran pronghorn within the study area (OPCNW, CPNWR, LAFBGR and BLM).

	#	Name	UTM	**Type
LAFB	13	Eagletank	2-81.7E X 36-11.5N	Tinajas
	2	Thompson Tank	2-81.3E X 36-09.3N	Catchment
	22	Mohawk Catch #1	2-58.8E X 36-04.4N	Catchment
	32	Mohawk Catch #2	2-52.2E X 36-06.4N	Catchment
CPNWR	3	Buckhorn Tank	2-25.5E X 35-86.5N	Tinajas
	4	Granite Pass Tank	2-87.5E X 35-77.7N	Catchment
	5	Papago Well	2-84.3E X 35-53.3N	Well
	6	Bussarise Tank	2-92.3E X 35-50.1N	Well
	7	Antelope Charco	2-91.1E X 35-52.9N	Charco
	8	Parra Tank	2-97.4E X 35-67.7N	Charco
	9	Redtail Tank	2-95.9E X 35-69.7N	Charco/Tank
	10	Jose Juan Tank	3-02.1E X 35-51.9N	Charco/Tank
	11	Bluebird Tank	3-16.5E X 35-64.9N	Well
	12	Adobe Windmill	3-14.9E X 35-72.3N	Well
	13	Charlie Bell Well	3-02.3E X 35-84.9N	Well
	14	Jack's Well	3-07.4E X 35-88.0N	Well
	15	Little Tule Well	3-16.5E X 35-82.9N	Well
	16	Chico Shuni Wells	3-16.7E X 35-78.1N	Well
	17	Eagletank	2-63.1E X 35-70.9N	Tinajas
	18	North Pinta Tank	2-52.3E X 35-82.9N	Tinajas
	19	Senita Tank	2-48.1E X 35-72.9N	Tinajas
	20	Tule Tank	2-41.4E X 35-68.6N	Well
	21	Buck Peak Tank	2-25.7E X 35-86.7N	Tinajas
	23	Cabeza Prieta Tank	2-36.3E X 35-78.1N	Tinajas
	34	Halfway Tank	2-30.7E x 35-81.3N	Tinajas
	35	Heart Tank	2-59.7E x 35-72.7N	Tinajas
OPCNM	24	Quitobaquito Springs	3-09.0E X 35-36.9N	Spring
	25	Burro Springs	3-09.1E X 35-36.9N	Spring
	26	Williams Springs	3-08.3E X 35-37.3N	Spring
	*27	Pozo Nuevo Well	3-08.9E X 35-73.9N	Well
	*28	Bates Well	3-16.1E X 35-60.7N	Well
	29	Bonita Well	3-13.5E X 35-42.9N	Well
BLM	33	Cattle Catchment	3-23.5E X 35-68.1N	Well
	30	Bandeja Well	3-18.9E X 35-66.5N	Well
	31	Cameron's Tank	3-18.1E X 35-70.7N	Charco/Well

* - Shut down by Park Service in May, 1984.
** - Charco = seasonal pothole, man-made.
Catchment = man made, storage tanks w/guzzler, filled w/water by AGFD or USFWS during dry seasons.
Tinajas = Seasonal natural tank or tank blasted out of mountain side, with retainer dam.

A half dozen cattle tanks are also found along the eastern border of the Sonoran pronghorn's range, and the Wellton-Mohawk Canal (from which two Sonoran pronghorn have been rescued) is located along the northern boundary.

The USFWS is currently considering reopening wells on the refuge in areas where herds of seven to ten animals are located.

III. OBJECTIVES OF STUDY

The primary objective of this study, as stated in the study proposal of June 1983, was to "obtain basic information that will contribute toward the development of a management plan to ensure the continued existence for the endangered Sonoran pronghorn." Documentation of life history, natality and mortality, and population movements and dynamics should provide some insight into the dispute on the taxonomic classification of the Sonoran pronghorn; development of a capture technique that would reduce mortality and injury was also desired.

To obtain the required information, 4 field techniques were employed; weekly aerial locations, ground locations, placement and periodic reading of 38 rain gauges, and vegetation transects conducted at sites of aerial location.

IV. CAPTURE

A. Methods

Prior to this study there had been no attempt to capture Sonoran pronghorn. A thorough literature review was made of available capture techniques which have been employed on pronghorn to select the most suitable capture method. In addition, wildlife biologists with expertise in ungulate capture were consulted on methodologies they have utilized. Some methods that were reviewed are: corral-type drive traps (Spillet and Zobell 1967), linear tangle nets (Miller et al. 1971), aerial darting with an immobilizer (Copeland et al. 1978, Autenrieth et al. 1981) and a hand-held net gun (Chris Isaac pers. comm. 1982, Barrett et al. 1982).

Based upon the review conducted, there were potential problems with all of the available capture techniques. Some of the experimental research done on pronghorn using a chemical immobilizer has caused high mortality. Autenrieth et al. (1981) reported a mortality rate of almost 20% in some recent capture work on pronghorn. The mortality rate for the male segment of the population was even higher (36%). Tests with Etorphine (M99) in Wyoming showed the reaction to the drug was somewhat unpredictable. In some cases, antelope reacted in a satisfactory manner, while others given the same dosage had severe problems related to drug injections. Copeland et al. (1978) reported little success and high mortality when using succinylcholine

chloride to capture free ranging pronghorn. Based upon the literature reviewed, it was decided that the use of immobilizing drugs to capture antelope would jeopardize the animals injected and mortality could be expected, in at least some instances. Therefore, this method was rejected as a practical technique to capture this pronghorn subspecies.

Two other methods that have been used on pronghorn utilize either linear drive nets or corral type traps where antelope are hazed into the nets and physically restrained. While these methods have been used with success in capturing large numbers of antelope, both are not without drawbacks. Chalmers and Barrett (1977) reported losses of 27% of the antelope that they had captured in a drive trap. Both of these methods are generally used when population numbers are high. In a very low density population as in the Sonoran pronghorn, placement of the net within a reasonable distance of a herd of pronghorn was considered impossible.

The hand-held net gun is another method evaluated prior to selection of a capture method. The AGFD conducted a study to evaluate the suitability of this method to capture free ranging desert mule deer (Odocoileus hemionus). During this study, which was conducted in 1982 on the 3-Bar Wildlife Area, mean chase time for six deer was 5.0 minutes. The range was from 2.0 to 8.0 minutes (Smith and Horejsi 1982). Barrett et al. (1982) utilized this technique to capture 5 pronghorn in Alberta (three does and two fawns). During this capture, one animal was lost due to

physical trauma. In addition, two pronghorn showed signs of capture myopathy (CM). Both animals with CM problems were fawns.

Conversations with Mr. Barrett indicated several factors led to the problem of capture myopathy. The helicopter used was an A-Star, which because of the seat arrangement, was difficult to fire the equipment out of. In addition, animals were held for a relatively long time. Based upon the capture of these animals Barrett et al. (1982) concluded "that pronghorn can be easily captured with this technique, but that considerable effort may be required to reduce losses from trauma or acute capture myopathy."

The literature review indicated that although all methods had inherent dangers to pronghorn, the hand-held net gun limited this danger to the greatest degree. The net gun was manufactured by Coda Enterprises, Mesa, Arizona. The net gun, which has 3 barrels, fires a triangular net that measures approximately 5.8m on each side. Each corner of the net has a weighted projectile which is seated in the barrels of the net gun. When fired, the weighted projectiles carry the net over the "target" animal. The apparatus is powered by a single .308 caliber blank. The barrels are ported to provide equal pressure to all barrels. To obtain best deployment, a height of 5-6 m over the animal was attempted.

Two fixed-wing aircraft were utilized in searching selected areas to locate pronghorn prior to the capture.

B. Results

Four male and six female Sonoran pronghorn were captured using the hand-held net gun. During capture efforts, all times were rounded to the nearest minute. Chase times ranged from 1.0 to 4.0 minutes with an overall mean of 2.8 minutes. The mean for 6 does ($\bar{x}$ = 2.3 minutes) was less than that for the 4 bucks ($\bar{x}$ = 3.5 minutes). The total time of the capture (from initiation of chase to release of animal) ranged from 5.0 to 11.0 minutes with a mean of 7.9 minutes. Mean values for females was 7.3 minutes, while the mean for males was 8.9 minutes (Table 4).

Three pronghorn were captured on October 28, 1983, 1 on October 29, 1983, and 6 on October 30, 1983. Recorded ages ranged from 1 year to 6 years, with 2 females being classed as adult. Dentition replacement and wear were used to estimate the age of animals.

C. Discussion

The capture effort began at daylight on October 28, 1983. The fixed wing aircraft searched different portions of the study area to minimize the potential for mid-air collisions. The first herd was located at approximately 8:45 a.m. The capture crew flew to the location and initiated the chase. It was predetermined that efforts would be made to segregate a buck from the herd and to capture the isolated individual. After repeated attempts the animals would not separate and a capture was made of

Table 4. Capture data on ten collared Sonoran pronghorn, collected October 28-30, 1983.

				SAMPLES COLLECTED					CAPTURE TIME				
Animal Freq #	Date	Sex	Age	Blood	Oral	Fecal	Vaginal	Nasal	Chase Begin	Capture	Release	Total	(F°) Temp
149.081	10/29/83	F	1½ Y	X	X	X	X	X	1752	1755	1800	8 min	104°
149.100	10/30/83	M	3-4Y						1037	1040	1047	10 min	98°
149.201	10/30/83	F	Ad	X	X	X	X	X	1651	1652	1701	10 min	
149.221	10/28/83	M	6Y	X					0918	0922	0925	7 min	104°
149.250	10/30/83	F	Ad.						0715	0717	0720	5 min	
149.260	10/30/83	F	1½ Y	X					1708	1710	1713	5 min	105°
149.281	10/28/83	M	5Y	X					1013	1017	1020	7 min	105°
149.290	10/30/83	F	1½ Y	X					0735	0738	0740	5 min	108°
149.311	10/30/83	F	3-4Y						1055	1056	1106	11 min	106°
149.380	10/28/83	M	1Y	X					1129	1132	1138	11 min	104°

Animal Freq #	Sex	Hind Foot (mm)	Total Length (mm)	Tail Length (mm)	Ear Length (mm)	Shoulder Height (mm)	Chest Girth (mm)	Neck (mm)
149.081	F	391	1384	122	152	787	749	302
149.100	M	—	1511	114	178	—	876	—
149.201	F	427	1524	117	157	909	859	302
149.250	F	—	1428	102	152	800	846	305
149.260	F	—	—	—	—	808	744	302
149.311	F	—	1461	102	157	851	897	376
149.380	M	—	1359	—	—	757	775	277

a buck from within the herd. The capture helicopter landed approximately 30 m from the restrained animal. The veterinarian present checked the animal to monitor stability. Rectal temperature and gum capillary response were constantly monitored and the animal was radio-collared. Because of concern for minimal jeopardy to the animal, few biological samples were collected and the animal released. The maximum rectal temperature recorded on this animal was 104°F. No further captures were made from this group due to the concern for capture myopathy resulting from prolonged chase.

Subsequent captures were similar to that described above. "Target" animals were almost impossible to segregate from the herd and the captures were made from within the group. On one occasion the net was fired over two pronghorn on the same shot; however, the area of the net was not sufficient to allow both animals to become entangled. On another capture, the animal was only partially entangled and had to be chased on foot. This prolonged the time of captured. On several captures, high body temperatures limited the ability to collect biological samples.

The results of this study indicate that the method selected was an effective technique to capture pronghorn. There were no indications that physical trauma or capture myopathy were a factor in this capture. All animals were fitted with telemetry equipment and survived at least six months past capture. Similar results on other species were achieved by deVos et al. (1984).

Biotelemetry collars that weighed 286 g were used. In order to use a smaller battery on the transmitter, photoelectric cells

were used on seven collars to increase battery life. All transmitters have a normal pulse rate of 55 beeps per minute; at night, the photocells reduce the transmitter to 15 beeps per minute. The mortality sensor on all collars is 15 beeps per minute, with a one-hour time lapse from active to mortality signal. Life expectancy on the regular collars is 12-18 months and 36-40 months for the photocell collars.

At the time of capture, biological samples such as body measurements, blood samples and swabs for bacteria growth were taken. The body measurements that were taken are presented in Table 4. Blood samples were submitted to Dr. Don Morizot, University of Texas, for electrophoretic examination. In 1985, samples from pronghorn transplanted to Arizona (different subspecies) were also sent for examination. To date none of the results have been returned to AGFD in spite of several letters requesting information being sent; if results are received, they will be included as an appendix to this report. The serology and culture work were done by the University of Arizona. Results of the completed tests detected no active disease or pathogens present. The necropsy conducted on a doe killed by coyotes during the study indicated that animal had no apparent disease factor present.

V. LOCATION METHODS

A. Aerial Location

Aerial locations of the collared Sonoran pronghorn occurred on a regular basis when clearance was provided and weather was satisfactory (Appendix 1). Clearance was obtained from Luke Air Force Base Command post; military maneuvers are regularly scheduled during the week and time was allotted for this project on weekends when airspace demands permitted. A small single engine aircraft equipped with a belly antenna and a Telonics TR-2 receiver with scanner was used for locations (LeCount and Carrel 1979). Once the signal was picked up, 10 to 15 minutes were spent pinpointing the signal and obtaining a visual of the pronghorn. To prevent stress, no animal was followed longer than 15 minutes. When possible, all pronghorn observed were classified as to age and sex. Actual locations were noted on a United States Geological Survey (USGS) topographic map and recorded as Universal Transverse Mercator (UTM) coordinates.

B. Ground Locations

When time and funds permitted, effort was made to locate selected collared pronghorn several times weekly (Appendix 2). Selection was made for those pronghorn located in areas with access or in areas where military clearance could be obtained. Once the pronghorn's signal was pinpointed, a spotting scope and

10x50 binoculars were used to observe pronghorn behavior. Observations were made from low hills within 1 km of the pronghorn. In order to reduce the stress on pronghorn, a distance of at least 350-500 m was maintained between the pronghorn and observer. Group composition and behavior were documented every 2 minutes for as long as visual sightings could be kept. When visuals were not obtained, signal strength, pulse rate and azimuth were used to triangulate locations to determine habitat use. Pronghorn without photocell collars were tracked at night to document nocturnal movements.

When possible, fecal samples were collected from areas used by the Sonoran pronghorn. Vegetation samples were obtained from plants pronghorn were observed browsing. Observations of tracks and buck rut-related scrape and void marking were documented and photographed.

Ground and aerial locations were mapped on a USGS topographic map. Each site was assigned a UTM coordinate, locating the site within a 200 km^2 area. For each location, 12 variables were noted on a standardized field data sheet: date, observer, time of observation, length of observation, UTM coordinate, vegetation type, group size and composition, behavior or activity, weather, military activity, proximity to water, and type of water source.

VI. SUMMARY OF INDIVIDUAL COLLARED PRONGHORN

The following is a summary of data collected on each collared pronghorn:

149.081

This doe was 1 1/2 years old when collared with a photocell collar. She was aerially located 48 times and observed once on the ground over a period of 24 months. She had a home range of 397.6 km^2 (average for all females was 465.7 km^2) that covered the mid to lower Growler Valley. During the winter and spring, she utilized the bajadas on the western slopes of the Growler Mountains, mainly near Temporal Pass. The rest of the year, she was found in the open valley from the northern edge of OPCNM to Salt Well. Long range movements (16-25 km) were made during September, October, and November; all of those movements were north/south in direction. #149.081 was observed with twins on April 14, 1985; one week later only one fawn remained. This doe was frequently relocated with doe #149.311 during the winter of 1984, and was in the largest herd observed during this study (December 1984).

149.100

The age of this buck was estimated at 3 or 4 years old when collared with a photocell collar. He was located 7 times during 8 months. His home range was 64.5 km^2 (average for all males was 799.7 km^2) and covered the northwestern corner of OPCNM and, to a

lesser degree, mid-Growler Valley. The majority of his locations were just southwest of the Growler Mountains; his remains were found on July 13, 1984, in the bajadas on the southern slopes of Growler Mountains. He apparently died of natural causes.

149.201

When collared with a photocell collar, this doe was classified as an adult. She was aerially located 31 times over 18 months. Her home range was 799.7 km^2; during the winter she was relocated in mid-San Cristobal Valley and during the summer she was found in the lower Mohawk Valley and Papago Well area. In June 1984 she was relocated near Granite Pass tank on the east slope of the Granite Mountains. #149.201 made the majority of long range movements from December 1984 to March 1985; she made one movement of 31 km from lower Mohawk Valley to mid-San Cristobal Valley. She was never observed with fawns. She was frequently relocated during the winter of 1984 with doe #149.260. She apparently died of natural causes in May 1985.

149.221

This buck was 6 years old when collared with a photocell collar. He was located 47 times from the air and observed twice on the ground over 24 months. He had a home range of 484.6 km^2, ranging from east of the Aguila Mountains to Childs Valley and the Little Ajo Mountains. From September to May, he ranged to the east of the Aguila Mountains; he was frequently found on a mock airfield on South TAC range. In May and early June,

#149.221 moved south (around the tip of the Growler Mountains) into lower Childs Valley. Each spring, he made one long range movement to his summer use area (16.4 km in 1984, 28.3 km in 1985). In August 1985, #149.221 made a long-range movement of 37.3 km from the summer use area back to the winter use area. He was often observed alone and appeared to be undisturbed by low flying AGFD aircraft. He was located in February 1985 with buck #149.380.

149.250

Doe #149.250 was collared as an adult with doe #149.290; she had a photocell collar. She was aerially located 28 times and located 19 times on the ground over 16 months. She had the smallest home range of the ten collared pronghorn (40.7 km^2), and remained in the Cameron Charco/Daniels Arroyo area of lower Childs Valley. Within her home range was a variety of vegetation and topographical types (creosote-bursage flats, bajadas, rolling hills and washes), three permanent water sources, and a fence crossing the eastern edge. There was moderate human and cattle traffic on the BLM side of the fence. The herd was tolerant of the observer as well as the airplane, and easily accessible to the observer; #149.250 and #149.290 were frequent target animals for ground observation. Her longest ranging movement was 8 km in September 1985. She was observed with fawns in March 1984, both of which remained with the herd that year. On February 23, 1985, she was again observed with fawns; one disappeared 5 days after

the initial observation. She was killed by coyotes on March 2, 1985 and the fate of the remaining fawn was unknown.

149.260

This doe was 1 1/2 years old when collared with a photocell collar. She was located 45 times over 24 months and had the largest home range of the does, 1143.7 km^2. During the winter, she was found in mid-San Cristobal Valley or in mid-Mohawk Valley; during the summer she was found around Papago Well and Antelope Hills. She made long range movements of 15-31 km during the winter, 16-37 km during the spring and 16-17 km during the fall. All movements were north/south in direction. She was not observed with fawns during this period. #149.260 was relocated with doe #149.201 during the winter of 1984.

149.281

The age of this buck was estimated as 5 years old when collared with a photocell collar. He was located 46 times aerially and located twice on the ground over 21 months. He had a home range slightly smaller than average (700.8 km^2). He was relocated in south Growler Valley from October 1983 to May 1984; on May 4, 1984, he was observed on the Pinacate Lava Flow in northern Mexico. No location was obtained until August 1984, when he was observed along the western border of OPCNM. He remained in that area, generally around low volcanic hills west of Quitobaquito Hills. His longest movements were only 8-10 km in distance.

149.290

This doe was 1 1/2 years old when collared with a conventional radio collar. She was located aerially 42 times and located 14 times on the ground over 22 months. She was found in the Cameron Charco area from October 1983 to February 1985. Attempts to locate her from February 14, 1985 to April 20, 1985, were unsuccessful; on May 4, 1985, her signal was received in the Cameron Charco area again. Her home range is 63.3 km^2. Her longest ranging movement was 11.6 km in a northwest direction in September 1985. She was observed with a fawn in June 1985; it remained with her throughout the year. #149.290 was located with #149.250 until #149.250 left the herd for fawning in 1985.

149.311

When captured, this doe was 3-4 years old and was collared with a conventional collar. She was located 50 times aerially and located once on the ground over 24 months. She had a home range of 349.3 km and was the most predictable of the collared pronghorn in use of seasonal areas. Her range covered lower Growler Valley from Saguaro Gap to Bates Mountain (on OPCNM). During the fall and winter, she was located in the open flats of Growler Valley; during the spring and summer she was found in the foothills of Bates Mountain. Each March, she returned to the same foothills for fawning. Long range movements of 13 and 22 km were made to these foothills in 1984 and 1985, respectively. #149.311 was observed with fawns in March 1984 (as of August 1984

only one was observed) and March 1985 (both survived). She was observed with doe #149.081 during the winter of 1984.

149.380

This buck was collared with a conventional collar when he was a yearling. He was located 43 times aerially and twice on the ground over 24 months. He has the largest home range of any collared pronghorn (1213.6 km^2), ranging from the Aztec Hills (south of Dateland) to Saguaro Gap (south of Granite Mountains) and from Mohawk Mountains to mid-Childs Valley. During the winter, he was relocated in the northwest portion of his range; in May of each year he returned to Charlie Bell Pass in the Growler Mountains. He made long range movements of 15-40 km throughout the year. He was located once with buck #149.211 in February 1985.

VII. MOVEMENT

A. Home Range

1. Methods

Home ranges were determined from the UTM coordinates of aerial locations. ARC/Info software (ESRI 1986) utilized the UTM system and USGS topographic quads to plot home range maps. A computer program adapted for AGFD use (Denny Haywood pers. comm.)

calculated home range size and mean activity radius for each collared pronghorn.

2. Results

Home ranges of the collared Sonoran pronghorn varied widely; males utilized home ranges from 64.5 km^2 (based upon 7 observations of buck #149.100) to 1213.6 km^2 (based upon 43 observation of buck #149.380) and females exhibited home ranges from 40.7 km^2 (based upon 28 observations of does #149.250) to 1143.7 km^2 (based upon 50 observations of doe #149.260) (Appendix 3 and Table 5). Overall, males averaged 1/3 larger home ranges than the females.

3. Discussion

Kitchen and O'Gara (1982) stated the large variation in home range size of pronghorn is due to variability in habitat quality, past history of grazing, population and group sizes, and season. Based upon the estimated home ranges of this study, Sonoran pronghorn use larger areas than those reported for other pronghorn subspecies.

Kitchen (1974) reported home ranges of 0.2 to 22.5 km^2 for A. a. americana; the ten collared Sonoran pronghorn exhibited home ranges of 40.5 to 1213.6 km^2. Home range size varied within sex, yet overall, males had larger home ranges than females.

Based upon the results of this study large home ranges

Table 5. Home ranges of individually collared Sonoran pronghorn, October 1983 to October 1985. N = number of relocations; Months = number of months relocated; Mean Activity Radius = average distance from geometric center to each point.

Animal #	Sex	N	Months	Home Range (sq. km)	Mean Activity Radius (km)
149.081	F	48	24	397.6	8.5
149.100	M	7	8	64.5	6.6
149.201	F	31	18	799.7	9.3
149.221	M	47	24	484.6	12.2
149.250	F	28	16	40.7	2.7
149.260	F	45	24	1143.7	20.5
149.281	M	46	21	700.8	5.3
149.290	F	42	22	63.3	2.9
149.311	F	50	24	349.3	8.5
149.380	M	43	24	1213.6	16.6
All	F			465.7 (SD=431.7)	8.4 (SD=6.5)
*All	M			799.7 (SD=374.4)	11.7 (SD=5.7)

*Excluding 149.100

appear to be tied to forage and possibly water availability. Those collared pronghorn that inhabit the lower, drier and sparsely vegetated areas of the northwestern portion of the study area had the largest home ranges. The collared pronghorn found in the southeastern portion of the study area (more densely vegetated with a variety of habitat types and with more permanent water sources) had the smaller home ranges.

B. Seasonal, Long Range, and Daily Movements

1. Seasonal Movements

The collared Sonoran pronghorn exhibited seasonal use of areas within their home ranges. During the winter, 8 of 10 collared Sonoran pronghorn were found in the north portion of their home ranges. During the spring, four of the collared pronghorn made long-range movements from their winter areas to their summer areas. Summer areas were usually in the southeasterly sections of the home ranges, in low rolling hills and bajadas. Fall use areas functioned as migratory corridors and were more variable in use than the other seasonal use areas.

Collared individuals had a high fidelity to certain areas. Two bucks, #149.380 and #149.221, returned to Charlie Bell Pass and Childs Valley (respectively) between the end of May and middle of June each year. Doe #149.260 was found in mid-San Cristobal Valley during the winter, and in the low hills east of Papago Well during the summer each year. Buck #149.281 moved

further south towards the Mexican border each spring, then moved 10 km north during the winter. Travel corridors were not as specific as summer and winter use areas, yet there were some notable exceptions. Charlie Bell Pass was utilized by at least two collared pronghorn for travel to and from Growler Valley and Childs Valley. Buck #149.221 preferred to travel around the northern tip of Growler Mountain when making long range movements between Growler Valley and Childs Valley. Doe #149.260 used Mohawk Valley rather than San Cristobal Valley for long range movements between her summer and winter use areas.

2. Long Range and Daily Movements

Long range movements between seasonal use areas occurred throughout the fall and just prior to summer. Two does, #149.201 and #149.260, moved 42.1 km and 42.6 km (respectively) when traveling to and from their summer areas. Buck #149.380 traveled 30-40 km during the spring to reach his summer area. Buck #149.281 traveled 30 km to and from Mexico in 1984 (the only collared Sonoran pronghorn to cross the International Boundary). Four collared does and two collared bucks made several movements of 15 to 25 km.

Average distance between locations varied between individuals and between sexes (Appendix 4, Table 6). Average distance between locations was less during the hottest part of the year for both sexes, when males averaged 6 percent less distance (0.4 km) between locations and females averaged 41

Table 6. Mean distance between locations, mean days between locations and mean distance moved per day (by season) for all collared Sonoran pronghorn October 1983 to October 1985.

Sex	Season *	N	Avg. Distance Between		SD	Avg. Days Between		SD	Avg. Distance/Day		SD
M	1	25	7.3 km		3.0	12.0	0	1.0	km	0.9	
	2	65	6.9	2.4	10.3	0.6	0.8	0.2			
	3	33	6.5	3.6	10.7	2.1	0.7	0.5			
F	1	40	8.8	6.0	15.0	3.2	0.8	0.4			
	2	13	5.2	1.8	10.8	1.5	0.6	0.2			
	3	70	6.8	4.1	9.2	0.4	0.8	0.5			

* 1 = Feb, Mar, Apr
  2 = May, June, July, Aug, Sept
  3 = Oct, Nov, Dec, Jan

percent less distance (3.6 km) between locations. Average distance moved each day varied between individuals; overall, females moved 0.2 km/day less than males during the spring and summer.

On the occasions where nocturnal tracking was undertaken, pronghorn remained active throughout the evening. Individual collared pronghorn often remained active until approximately 11:00 p.m. during the summer period. During nocturnal tracking efforts, no movements in excess of 2 km were observed. Nocturnal movements usually were slower than movements observed during daylight hours.

3. Discussion

North American pronghorn migration between summer and winter ranges may involve distances of 18 to 160 km and are in response to forage, rather than climatic, conditions (Kitchen 1974). Sonoran pronghorn exhibit similar seasonal migration patterns, and these movements appear to be in response to the same conditions.

Kitchen and O'Gara (1982) observed the shortest movement per day during the spring (1.3 km/day) and the longest during the fall (3-10 km/day) for A. a. americana. The collared Sonoran pronghorn exhibited no definite pattern in distances moved, yet females average less movement per day during the spring, summer and early fall. The decrease in movement may be in response to

parturition and lactation demands on the does, and to the increase of forage availability in the bajadas, which the does use during the spring and summer.

VIII. HABITAT

A. Methods

Vegetation type and topography within 100m of the location site were determined for all aerial locations. Five vegetation types were designated as described by Brown and Lowe (1980): creosote-bursage (154.111), paloverde-mixed cacti (154.122), paloverde-smoketree (154.123), paloverde-saguaro (154.121), and urban (such as Mexico, where vegetation determination could not be made). Topography was described as flat, hills, bajada, mountain, drainage, sand dunes, lava flow and other (Mexico or Ajo).

Arizona Land Resource Information System (ALRIS) programs were used to analyze habitat parameters on 383 pronghorn locations. An SPSS (Norusis 1985) subprogram was used to select 400 random UTM coordinates drawn from a uniform distribution of UTM coordinates within the study area. Habitat parameters were determined for these 400 points; Chi-squared tests (Sokal and Rohlf 1969) were used to compare observed use of habitat features to expected values generated from random locations.

Vegetation transects were conducted on 136 sites of aerial

locations of collared pronghorn (Appendix 5). Five sites from four areas where pronghorn were collared (military range, Mohawk Valley to Papago Wells, Growler Valley and OPCNM) were randomly selected each month. At each site, a 100-meter-long line intercept transect (Lucus and Seber 1978) and a MacArthur board technique (MacArthur and MacArthur 1961) were conducted.

1. Vegetation

a. Results

A significant difference was determined between the expected (random value) and observed percentage use of vegetation types by collared pronghorn (X^2 = 152.92; $P \leq .001$) (Table 7). The number of random locations in the creosote-bursage association was 189 (47.3%) versus 245 (68.1%) actual locations. The paloverde-mixed cacti and paloverde-saguaro habitats occurring on the bajadas were used in approximately the same ratio as the random locations (57 locations, 15.8% actual/52 locations, 13.0% random). The use of ephemeral washes was greater than expected. There were 57 locations (15.8%) in this habitat type while only 35 random locations (8.8%) occurred there. Although 48 random locations (12.0%) occurred on the paloverde-saguaro covered mountains, no pronghorn locations were made in this habitat.

Data collected on line intercept transects were used to evaluate species composition, percent cover, percent occurrence and relative density for perennial plant species. Common name,

Table 7. Percentage of expected and observed utilization of vegetation types and topographic features by ten collared Sonoran pronghorn, October 1983 to October 1985.

Vegetation

	N	Creosote/bursage	Paloverde/mixed cacti	Paloverde/smoketree	Paloverde/saguaro	Mexico/Urban
Expected	400	47.3%	12.8%	8.8%	12.0%	19%
Observed	360	68.1%	15.8%	15.8%	0	0.3%

$X^2 = 152.9$
$P<.001$

Topographic

	N	Flats	Hills	Mountains	Bajada	Drainages	Sanddunes	Lavaflow	Mexico/Urban
Expected	400	41.2%	5.2%	12.0%	12.3%	8.8%	0.8%	0.8%	19.1%
Observed	360	56.7%	10.8%	0	15.8%	15.8%	0.6%	0	0.3%

$X^2 = 165.1$
$P<.001$

scientific name and four letter code for each species encountered is listed on Appendix 6. Thirty-two plants could be identified to the species level, with four only identified to genus.

The sparseness of the vegetation where pronghorn are found is evident from the density estimates from the data collected. There were only five species where the density estimate exceeded 1.0 plants/100 m^2. Triangle leaf bursage and creosote bush were the most abundant species. In habitats where these two species were encountered, they always were found in densities greater than 1.0 plant/100 m^2. When combined, these two species comprised more than 50% of the total number of plants encountered. Based upon the number of species encountered on line-intercept transects, two habitat types, creosote-ocotillo and paloverde-ironwood, were most diverse. Twenty five species were encountered in both of these habitat. Creosote-bursage had the next highest number of species with 16 represented at least once (Appendix 7).

Percent cover was also estimated from the line-intercept data. The total percent cover ranged from approximately 12% in the creosote-bursage type to approximately 32% in paloverde-mesquite covered drainages. The dominance of creosote bush and triangle leaf bursage in Sonoran pronghorn habitat was evident from these data. These two plants were the only species where percent cover estimates for all habitats combined exceed 1.0% (Appendix 8).

b. Discussion

AGFD Special Report #10 (1981) stated that Sonoran pronghorn were not frequently found in the creosote bush-bursage association, and that the more heavily vegetated areas of bajadas and mountain sides were selected (due to an increase of available forage in those areas).

In contrast, we found collared Sonoran pronghorn in the creosote-bursage association year round. This association was utilized for travel corridors, escape routes, and daily ranging. The paloverde-mixed cacti association was preferred from late winter to early fall, when winter and summer rainfall produced an abundance of forage in the bajadas. Does also preferred this association in spring for fawning. Washes and paloverde-mesquite stands were used throughout the year, with summer showing a higher incidence of use. Collared pronghorn were often located during mid-morning flights bedded under paloverde or mesquite trees.

The increase in use of the more densely vegetated wash associations during the summer can likely be attributed to the high percent cover in these areas. The relatively dense cover provided in these areas afford the ability to avoid or dissipate some of the heat load built up during hot summer days. On location flights in the summer period, it is difficult to force pronghorn out of washes onto the flats where identification can

be made. Because of the importance of desert washes to pronghorn, management and protection of these habitats is essential to maintaining pronghorn in the area.

2. Topography

a. Results

The 10 collared Sonoran pronghorn were located in 6 of the 8 topographic areas described for the study area (Table 7). There was a significant difference between the expected (random) and observed utilization of these features ($X^2 = 165.1$; $P<.001$).

Sonoran pronghorn used flat valleys to a greater degree than random with 204 (56.6%) actual locations occurring there and 165 (41.3%) of the random in this topographic feature. While this use occurred yearlong to some extent, use in the fall and winter was concentrated here. Isolated hills, which usually occur within the valleys and have an overstory of either paloverde-mixed cacti or creosote-ocotillo, were also used to a greater degree than the random value. Actual use of hills occurred on 39 locations (10.8%) while the random value was 21 locations (5.3%). As indicated in the vegetation section, no pronghorn use occurred in the mountain area although 48 random locations (12.0%) occurred there. The sand dunes occurred on 0.8% of the study area and were used by pronghorn on two occasions (0.6%).

The bajadas and drainages were used by pronghorn during

spring and summer. Does moved into the bajadas during early spring, the area where fawning occurred.

b. Discussion

The Pinta Sands area has long been assumed to be a prime location for pronghorn (Carr 1971, 1972). Large numbers were observed in the region during studies by AGFD in the late 1960s yet, since the late 1970s (when CPNWR personnel began frequent trips through the area), only 5 to 10 animals have been seen at a time. The area is without a permanent water source and, during the extremely dry early 1970s, a movement out of the Pinta Sands to more mesic areas to the east is believed to have occurred.

Approximately 40 percent of the Sonoran pronghorn were observed in Growler Valley, ranging from the Aguila Mountains to the International Border, in December 1984. CPNWR visitors and personnel frequently observed uncollared pronghorn along the Camino del Diablo and Growler Road (both winding through the flats), and occasionally near Charlie Bell Pass (in the bajada areas just to the east or west of the pass).

Three of the collared pronghorn (does #149.250 and 149.290, and buck #149.281) utilized a variety of topographic types year round. All three ranged in the southeast portion of the study area, where the widest variety of topographic features and vegetation types occur and elevation is highest.

IX. RAINFALL MEASUREMENTS

A. Methods

Rainfall was calculated from 38 rain gauges placed every 8 km along administrative roads on eastern CPNWR, western OPCNM, and southern LAFBGR (Table 8, Figure 6). Seven-foot posts were placed approximately 20 m from the road, and plastic gauges with 0.05-inch gradations were affixed to the fence posts. A layer of motor oil or transmission fluid was placed in each gauge to prevent evaporation. Gauges were lashed to the posts to prevent raptors from tipping gauges out of the brackets. Each gauge was tagged with an identification number.

B. Results

The rain gauges were read monthly in 1984 and bimonthly in 1985 (Appendix 9). A cumulative total and average of all surveyed gauges for each season was determined (Table 9). The longest monsoon season to date was recorded during the summer of 1984, and as a result, the average rainfall per gauge was high during this season (46.3 mm, SD=13.2).

Within each season, rain gauges with extremely low and extremely high readings were plotted on maps to determine seasonal trends in rainfall patterns that might influence pronghorn movement.

Table 8. Rain gauge locations and numbers on CPNWR, OPCNM, LAFBGR and BLM.

	Gauge #	Date Installed	UTM Coordinates
I. Papago/Tule Desert	33	06/28/84	3-19.5Ex35-62.7N
	17	06/29/84	2-98.5Ex35-54.1N
	16	06/29/84	2-91.5Ex35-47.3N
	40	06/29/84	2-83.5Ex35-54.1N
	15	06/29/84	2-75.2Ex35-52.6N
	38	06/29/84	2-69.1Ex35-53.5N
	39	09/06/84	2-64.1Ex35-55.0N
II. Mohawk Valley	13	07/06/84	2-82.7Ex35-59.5N
	12	07/06/84	2-79.1Ex35-64.9N
	11	07/06/84	2-72.1Ex35-74.3N
	37	07/06/84	2-67.9Ex35-81.0N
	10	07/14/84	2-73.7Ex35-85.3N
III. OPCNM	35	07/07/84	3-08.4Ex35-44.3N
	20	07/07/84	3-04.9Ex35-50.5N
	18	07/07/84	3-06.6Ex35-58.1N
	34	07/07/84	3-13.6Ex35-61.5N
	33	07/07/84	3-19.4Ex35-62.6N
IV. Adobe Hs.	32	06/28/84	3-21.1Ex35-67.9N
	30	06/28/84	3-15.9Ex35-72.1N
	29	06/28/84	3-09.9Ex35-78.1N
	36	09/14/84	3-18.1Ex35-69.7N
V. Childs Valley	1	06/27/84	3-18.1Ex35-86.5N
	28	06/27/84	3-12.1Ex35-84.3N
	27	06/28/84	3-06.1Ex35-86.1N
	2	06/27/84	3-11.1Ex35-92.1N
	3	07/18/84	3-05.7Ex35-98.1N
	31	07/19/84	3-22.1Ex35-76.5N
VI. Growler Valley	21	07/11/84	3-03.5Ex35-62.9N
	22	07/11/84	2-96.3Ex35-69.9N
	23	07/11/84	2-92.4Ex35-73.3N
	24	07/11/84	2-93.7Ex35-84.7N
	26	07/11/84	3-00.3Ex35-84.2N
	19	06/29/84	3-03.3Ex35-52.1N
VII. LAFBGR	4	07/14/84	3-01.3Ex35-01.5N
	25	07/14/84	2-90.9Ex35-93.9N
	6	07/14/84	2-86.5Ex36-00.7N
	5	07/14/84	2-86.7Ex36-06.1N
	7	07/14/84	2-78.3Ex36-00.7N
	8	07/14/84	2-72.3Ex35-96.3N

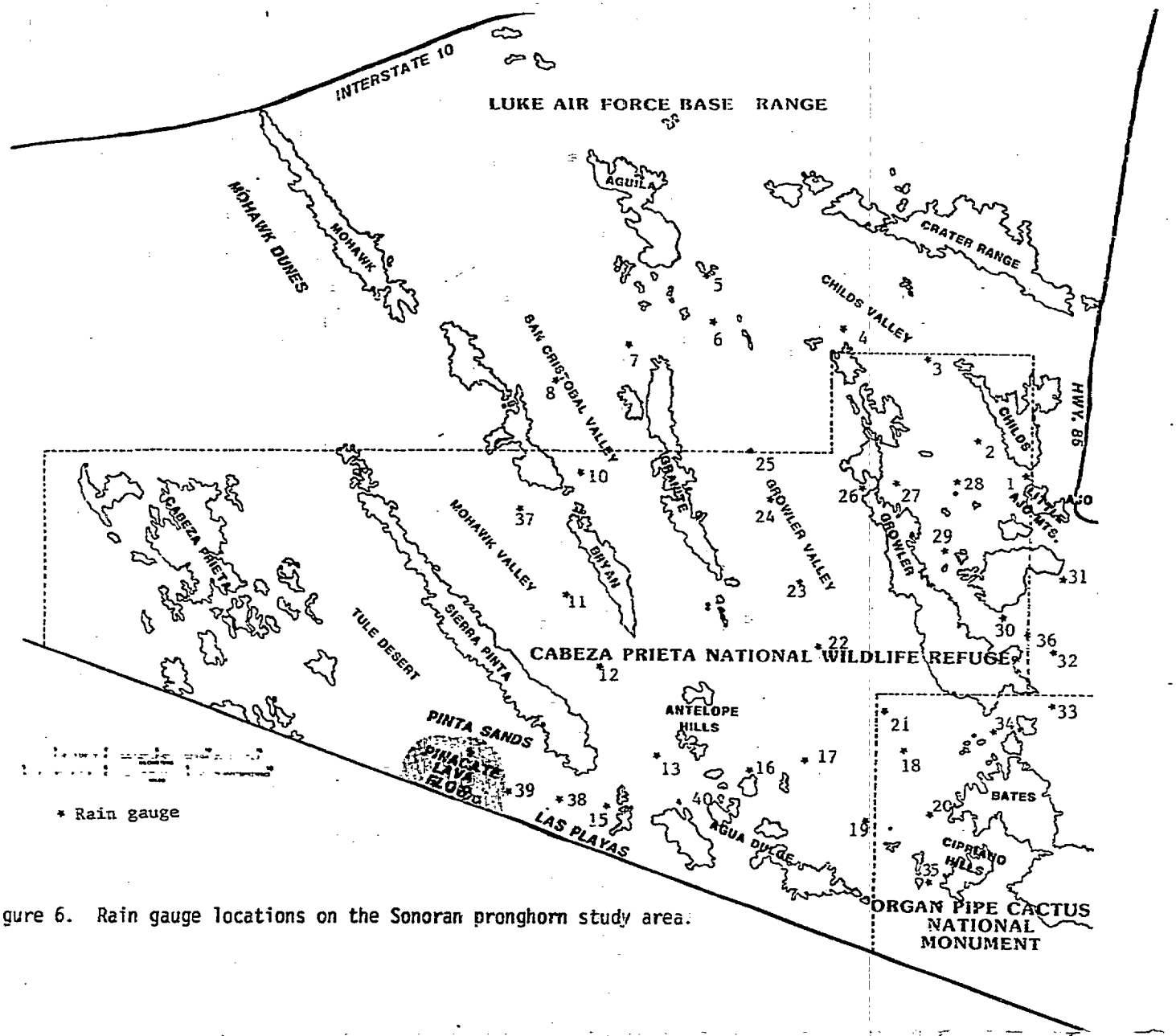


Figure 6. Rain gauge locations on the Sonoran pronghorn study area.

Table 9. Seasonal cumulative totals and averages for 38 rain gauges on CPNWR, OPCNM, LAFBGR, and BLM, July 1984 to October 1985.

Gauge #	Summer 1984		Winter 1984		Spring 1985		Summer 1985	
1	49.5mm		8.5mm	(-) *	19.1mm	(+)		
2	45.7		10.6	(-)	18.4	(+)	0.0mm	(-)
3	21.6	(-)	6.8	(-)	15.0		0.0	(-)
4	41.3	(-)	22.5	(+)				
5	25.4	(-)	31.1	(+)				
6	25.4	(-)	28.0	(+)				
7								
8								
9	Not Put Out							
10			27.1	(+)				
11	26.1	(-)	18.6	1.1	(-)			
12	25.4	(-)	33.9	(+)	15.2			
13	34.3	(-)	33.0	(+)	17.8			
14	Not Put Out							
15	66.5	(+)	5.5	(-)	19.1	(+)		
16	45.7		15.7	8.9	0.0	(-)		
17	60.4	(+)	13.6	8.9	0.0	(-)		
18	50.0		17.4	20.1	(+)		20.7	(+)
19	43.2		17.0	45.1	(+)		7.9	(+)
20	48.9		30.0	(+)	11.7		0.0	(-)
21	43.3		12.1		14.3	(+)		
22	46.1		6.4	(-)				
23	31.8	(-)	12.1					
24	63.5	(+)	7.6	(-)				
25								
26	59.7	(+)						
27	46.6		6.4	(-)	6.6	(-)	28.6	(+)
28	48.7		9.3	(-)	6.9	(-)	1.9	
29	65.8	(+)	11.9	6.1	(-)		3.2	
30	64.8	(+)	15.2	7.9	1.9			
31	55.5	(+)	12.7					
32	51.7	(+)	16.5	17.2				
33	42.4	(-)	19.5	(+)	17.8		6.2	
34	59.6	(+)	19.1	15.9	13.6	(+)		
35	64.8	(+)	21.2	(+)	15.9		3.1	
36			13.1	16.5	6.4			
37	35.0	(-)	21.2	(+)				
38	43.6		11.0	15.9				
39			10.6	(-)	15.9			
40	50.4		9.7	(-)	15.9			
	x=46.3mm (SD=13.2)		x=16.3mm (SD=8.1)		x=15.0mm (SD=8.2)		x=6.8mm (SD=8.5)	

* - = low gauge readings
+ = high gauge readings

No particular trend or patterns were discerned from rain gauge readings; gauges with low and high readings were located together during all seasons. Therefore, further analysis is unwarrented.

X. LIFE HISTORY

A. Group Composition

1. Methods

Group composition was determined from aerial locations of all collared pronghorn. Observations were sorted by month and average number of bucks, does, fawns and unknowns were determined. Sex ratio for the total population was calculated from an aerial location of 56 collared and uncollared pronghorn on December 22, 1984.

2. Results

The observed sex ratio for the Sonoran pronghorn was 60:100:50. Herd composition varied by season (Table 10). Collared pronghorn were often solitary from late winter to early spring. During the late spring, herds were comprised of does and associated fawns; occasionally a solitary buck was observed with these nursery herds as summer progressed. Bucks and does banded

Table 10. Monthly average herd sizes of collared Sonoran pronghorn October, 1983 to October 1985. N = number of relocations.

Month	N	Overall Herd Size	Average Males/Herd	Average Females/Herd	Average Yearling Herd
*January	17	8.7	3.1	4.6	0
February	15	5.7	2.1	3.6	0
March	19	2.3	0.7	1.5	0.1
April	16	2.0	0.4	0.9	0.8
May	13	3.2	0.8	1.8	0.6
June	19	4.1	0.6	2.5	0.9
July	11	3.2	1.0	1.6	0.5
August	26	5.6	1.5	3.4	0.7
September	35	5.5	1.3	3.5	0.7
October	13	5.1	1.3	3.6	0.2
*November	42	6.5	1.3	2.4	0
December	25	8.6	3.1	5.4	0.1

* Average herd size includes unclassified individuals.

together during the remainder of the year. The buck to doe ratio was narrowest during winter and July (68:100 and 63:100) and widest during the fall (24-44:100). Buck #149.380 was observed in all male herds only twice; both observations were during the fall of 1984.

Fawns were observed mainly during the spring, summer, and fall. Distinguishing fawns from adults became difficult in winter; the lower fawn observation rate during the winter may be a result of this difficulty.

3. Discussion

Carr (1973) estimated the sex ratio of Sonoran pronghorn to be 56:100:28 (n=493) on the CPNWR during a five year period. The current ratio varies slightly from the Carr estimate; regular observation during all seasons resulted in an increase in fawn observations. Both estimates fall in the middle range of pronghorn sex ratios (20:100 to 91:100) estimated by Kitchen (1974).

Seasonal sonoran pronghorn group composition was similar to the composition of the northern subspecies of pronghorn. One notable exception was males associated with females throughout the summer, fall, and winter.

B. Group Size

1. Methods

Group size was determined from aerial locations of all collared pronghorn. Total population size was calculated from aerial and ground locations of collared and uncollared pronghorn from December 15 to December 30, 1984.

2. Results

All collared Sonoran pronghorn were observed alone on at least one occasion during the study; the largest herd observed was 21 pronghorn in the lower Growler Valley in December 1984. Mean group size observed during this study was 5.1 animals (SD=2.2). A total population of 85-100 Sonoran pronghorn is estimated in Arizona.

A seasonal group size was evident in the Sonoran pronghorn. Large congregations of 6-15 animals were observed during the late fall and winter; these herds began to fragment during the late winter with solitary pronghorn being common during the spring. Medium sized herds of 5-6 Sonoran pronghorn were observed during the summer and early fall (Table 10).

3. Discussion

In Wyoming, pronghorn congregate into herds of 1000 or more animals during certain seasons (Kitchen and O'Gara 1982). Throughout northern Arizona, herds of A. a. americana numbering 30 to 100 individuals are frequently seen. In contrast, the Sonoran pronghorn is often seen in herds of 4 or 5 individuals.

The total population estimate for Sonoran pronghorn was based on aerial and ground observations on most of CPNWR, OPCNM and LAFBGR from December 15 to December 30, 1984. Due to the congregation of herds, the great distances between herds, and little change in group composition or size, this estimate reflects little, if any, duplication in count. Fifty-six pronghorn were sighted during a single telemetry flight. Seven others were known to be in mid-Growler Valley but not associated with any collared pronghorn in the area, and 20 other pronghorn that were not collared were observed by AGFD personnel, USFWS personnel and US Border Patrol agents during that period. This number reflects one of the first nonduplicated counts of Sonoran pronghorn, yet it concurs with previous population estimates.

C. Food Habits

1. Results

Perennial grasses and forbs were abundant during the summer and fall of 1984 because of the long monsoon season. Sonoran

pronghorn were observed browsing on forbs, shrubs, and cacti. Forbs and chain fruit cholla were browsed on during the summer and fall seasons, and brittle bush, chain fruit cholla, and ocotillo leaves were browsed on the remainder of the year. Forbs were found uprooted and browsed upon in areas where collared Sonoran pronghorn were located.

2. Discussion

Seasonal vegetative growth occurs following the summer and winter rains and, as a result, pronghorn are opportunistic foragers, as determined by fecal analysis (AGFD 1981). Forbs occur in large numbers during the spring and fall and are an important food species during those seasons. Shrubs and annuals are selected during the winter, and cacti are selected year-round. Fecal analysis was conducted from 1974 to 1977 by the AGFD showed 69% forbs, 22% shrubs, 7% cacti, and 0.4% grasses. Ranchers in the OPCNM region observed pronghorn feeding on cholla fruit, and AGFD personnel observed pronghorn feeding on brittlebush, bladderstem, paloverde, and plaintain in the spring (Carr 1970). Monson (1968) stated that Sonoran pronghorn fed on dried and withered remains of annual and perennial plants. Cholla fruit has been observed as a favored food; it has a high water content and can be found throughout most of the year.

Collared Sonoran pronghorn have similar food habits to the other southern subspecies but take advantage of regionally abundant vegetation, such as chain fruit cholla and paloverde.

D. Water

1. Methods

Distance (km) to the closest known water source was determined for all aerial locations. A frequency distribution was generated for distance to water sources for 1984 and 1985; a Chi-square test determined no significant difference (X^2 = 6.21; P<.001) between the two years.

An SPSS subprogram was used to select 400 random UTM coordinates drawn from a uniform distribution of UTM coordinates within the study area. Distance (km) to the closest known permanent water source were determined for these 400 points and a frequency distribution was generated. The frequency distribution of the random points was compared to that of the Sonoran pronghorn. The average distance to a known permanent water source was calculated for each individual collared pronghorn, and per month for all 10 collared pronghorn

2. Results

The 10 collared Sonoran pronghorn exhibited nonrandom movement in relation to water sources. A Chi-square test indicated a significant difference (X^2 = 303.16; P<.001) between the frequency distributions of the random points and collared pronghorn (Figure 7). Collared pronghorn were located closer to water sources than would be expected.

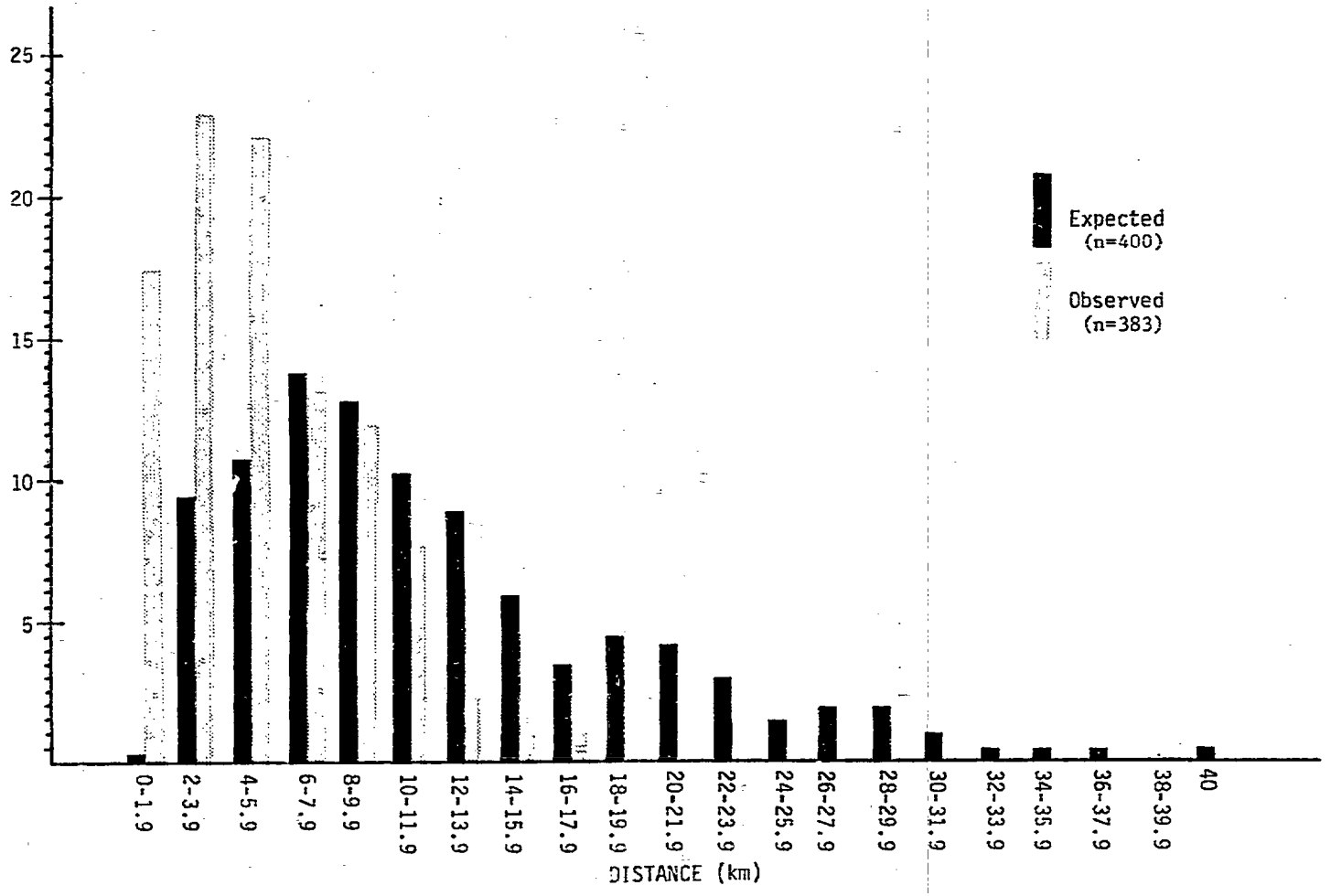


Figure 7. Frequency distribution of expected and observed distances to closest permanent water source for ten collared Sonoran pronghorn, October 1983 to October 1985.

The mean distance to a water source for individual collared pronghorn ranged from 1.7 km to 9.2 km; females averaged 2.2 km closer to a water source than males (Table 11). Collared pronghorn appear to exhibit seasonal movement in relation to water sources. The average distance to a known water source per month for the 10 collared pronghorn varied from 3.6 km during August (prior to the monsoons) to 7.2 km in May (Table 12, Figure 8).

Sonoran pronghorn were observed at water troughs in November, January, and August. Tracks were observed leading up to, then away from seasonal potholes during the monsoon season. In September 1985, a member of the Arizona Desert Bighorn Sheep Society observed six Sonoran pronghorn standing around Jack's Well guzzler (Larry Heathington, pers. comm.).

3. Discussion

Monson (1968) stated that there is "no hard evidence that they (Sonoran pronghorn) ever drink water even though it may be available," and that there is "no point in developing water specifically for these animals." He hypothesized that, since these animals were found where there is no water, they must get sufficient amounts of moisture through succulent plants, and have physical and physiological adaptations that conserve water. In Sonora, Mexico, these pronghorn are found in areas without any water sources and apparently do not travel the long distances required to reach water. Studies conducted on pronghorn in the

Table 11. Average distance to a permanent water source for each collared Sonoran pronghorn, October 1983 to October 1985. N=383

Freq #	Sex	N	Average Distance (km)
149.081	F	48	5.9
149.100	M	7	3.0
149.201	F	31	6.6
149.221	M	46	9.2
149.250	F	28	1.7
149.260	F	43	6.4
149.281	M	45	4.5
149.290	F	42	2.0
149.311	F	50	4.9
149.380	M	43	6.7
*All Males		141	6.8
All Females		242	4.6

*Excluding 149.100

Table 12. Average distance in kilometers to a permanent water source per month for all collared Sonoran pronghorn (N=383), October 1983 to October 1985.

Month	N	Distance to Water (km)
Jan	18	6.9
Feb	18	6.9
Mar	39	6.3
Apr	17	6.2
May	30	7.2
June	39	5.2
July	17	4.5
Aug	47	3.6
Sept	65	6.8
Oct	18	6.7
Nov	46	6.4
Dec	33	5.6

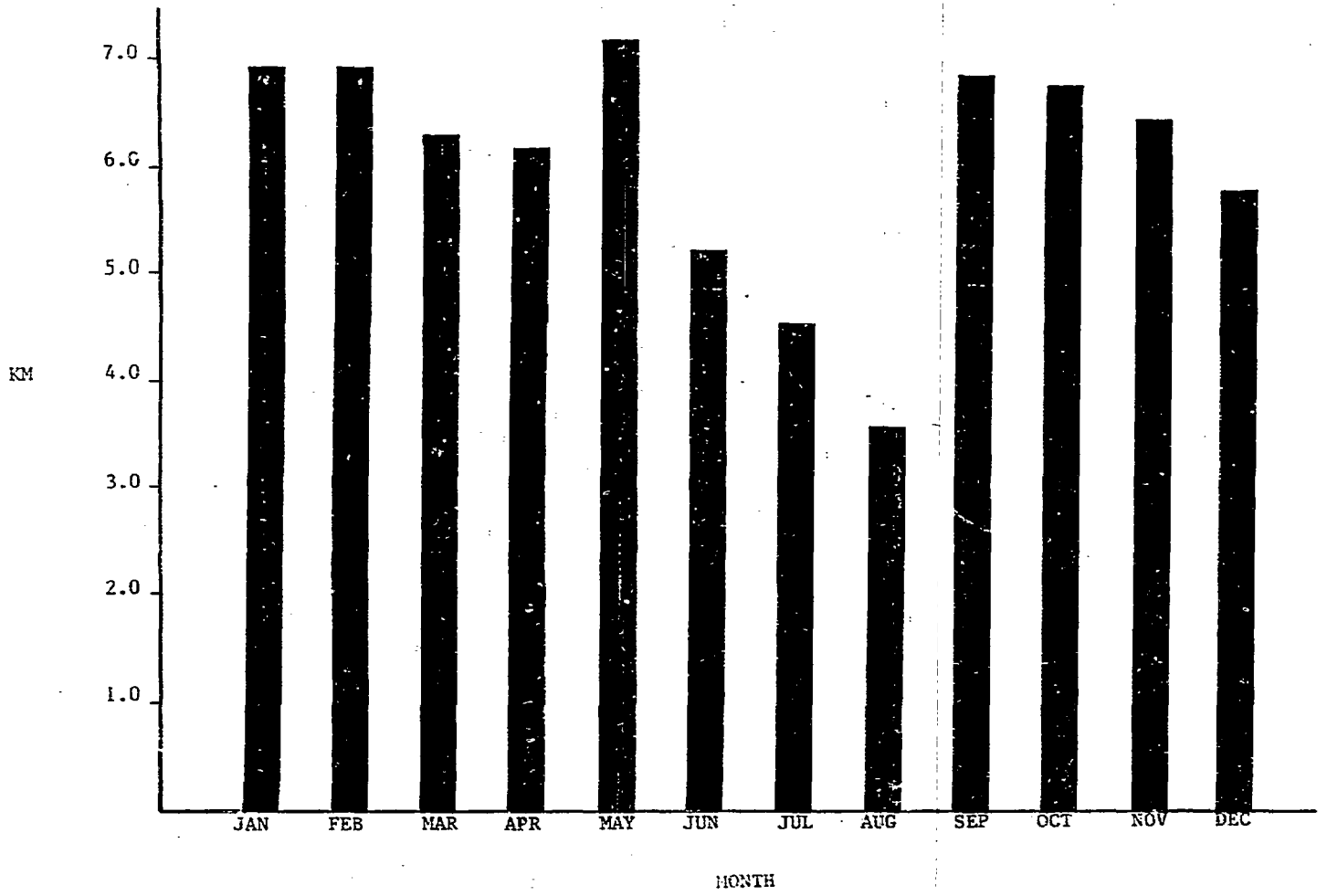


Figure 8. Average distance in kilometers to a permanent water source per month, for ten collared Sonoran pronghorn (n=383), October 1983 to October 1985.

desert plains of the western U.S. have shown that they do need water, particularly in the summer, but are opportunistic in drinking (Carr 1973). Beale and Smith (1970) found that there was an increase in water consumption by A. a. americana in Utah when water content of succulent plants was less than 75%. When the vegetation was dry (water content less then 39%), up to three liters of water per day was consumed by the pronghorn. A July 1967 census in Red Desert, Wyoming, found 95% of the pronghorn were within 5 km of open water (Sundstrom 1968).

The collared pronghorn exhibit movements apparently tied to water (as well as forage) availability. The observation of tracks and pronghorn around potholes and water sources, as well as the seasonal proximity of collared pronghorn to maintained water sources, suggests Sonoran pronghorn are opportunistic drinkers.

E. Behavior

Sonoran pronghorn antelope exhibit the same social, doe/fawn, territorial, and flight behaviors as noted for the other four subspecies. A heightened response to human traffic has been noted. Once aware of an observer, Sonoran pronghorn are quick to leave the area. One herd was observed 1 1/2 hours later, 18 km north of the point of initial observation in October 1984. Other pronghorn have run until out of the observer's sight when disturbed.

XI. Natality

1. Methods

Data on natality were collected both on aerial and ground locations.

2. Results

Four of the 6 collared doe Sonoran pronghorn had fawns during the study. Two does, #149.250 and 149.311, were each observed with fawns in March 1984. Both of #149.250's fawns survived (one buck and one doe) and remained with her until February 1985, when #149.250 left the herd to give birth to twins. One fawn was missing one week after initial observation; the remaining fawn (a doe) disappeared when #149.250 was killed by coyotes. In March 1984, #149.311 was observed with twin fawns; during an aerial location in August, she was observed with only one doe fawn. In March 1985, #149.311 again had twins, both were still alive as of September 1985.

Two other does, #149.081 and #149.290, had fawns in 1985. #149.081 was observed with twins in April (only one survived) and #149.290 was observed with 1 fawn in June (still surviving in September 1985).

In 1984, of all the does observed only 4 had fawns. Each of these does were observed with only 1 fawn. In contrast, in 1985, 10 does were observed to have fawns, with twins observed in 7

cases. The fawn/doe ratio using all data combined, including does observed without fawns resulted in the following ratios: 1984 - 33:100; 1985 - 50:100.

3. Discussion

Prior to this study, little was known about the reproductive behavior of the Sonoran pronghorn other than the fawn drop was during the early spring (Phelps 1974). Pronghorn does usually become sexually mature at 16 months and bucks are capable of breeding at one year (Kitchen and O'Gara 1982). Other pronghorn subspecies go through rut during the fall and fawn during the summer to take advantage of temperate weather and summer browse. Gestation for all A. americana subspecies is approximately 240 days (Asdell 1946).

Sonoran pronghorn have been observed with fawns from February through May during this and previous studies. Parturition in February-May places rut during July, August, and September, the hottest part of the year. Despite the stress of summer rutting on pronghorn, spring drop is desirable to coincide with temperate weather and spring forage. Fawns were infrequently observed at other times of the year (mainly summer or early fall).

An adult buck, associated with two collared does (#149.250 and #149.290) and two other does, was observed in rut in July and August 1984. He frequently left scrape and void markings and displayed several times at the observer when she approached too

close to the herd. No copulations were observed; however, three of the four does in the herd were observed with fawns in spring 1985. Scrape and void markings have been observed from July to October.

XII. Mortality

1. Results

Three collared Sonoran pronghorn died during the study; two of unknown causes and one due to predation.

Buck #149.100 was located on July 13, 1984, on OPCNM at the southern end of the Growler Mountains. The skeleton was disarticulated and spread out over a 10 m^2 area in a paloverde/mixed cacti habitat, with a wash running through the area. All of the skeleton was recovered except one forelimb, both scapulas, and ribs. Some skin and hair was left on the remains; coyotes and vultures had scavenged the carcass, which was evident by scats and feathers found around the skeleton. Cause of death was unknown.

Doe #149.250 and one fawn were visually located in the Growler Mountains foothills during a ground location attempt on February 28, 1985. Approximately 18 hours later, she was located from the air, in the same area with a mortality signal. A normal pulse rate was received when biologists attempted to locate the doe on ground. A visual observation was made of #149.250's doe

fawn in a wash at the base of the foothill. The carcass of the doe was located when the radio collared Sonoran pronghorn signal returned to one beep every four seconds. Fresh coyote tooth marks were found on the carcass. Movements of the predator had reactivated the normal signal pulse rate and the radio returned to the mortality mode. The carcass was found under a paloverde tree at the top of a hill. There was evidence of a chase and kill. The carcass was intact and rigor mortis had not yet set in; the pronghorn had been dead only a few hours. Her left flank was missing, as were all organs except the rumen, lungs, heart, thyroid, and a small section of liver. There were hold marks at the base of her neck (none punctured the skin). Necropsy revealed the wounds and mode of consumption were typical of a coyote kill. Harley Shaw, AGFD lion specialist, examined the carcass and determined the canine punctures to be too narrow to have been inflicted by a lion. Analysis of the organs showed no evidence of disease.

Doe #149.201 was located with a mortality signal on the CPNWR during a telemetry flight on May 11, 1985. The signal was difficult to pick up and was missed during a flight one week earlier. One attempt to locate her on the ground was unsuccessful; she was finally located on May 20, 1985. Her carcass was fully intact and mummified, with only a few scavenge marks made by turkey vultures. She had fallen with her transmitter under her; this caused the difficulty in receiving the signal. Cause of death was unknown.

All three carcasses have been deposited at the U.S. National Museum of Natural History. As of September 22, 1986, two of the three carcasses were still being prepared for examination. Plans are being made for the examination and measurement of the skulls by the USFWS Office of Endangered Species, and an addendum to this report will be submitted upon final examination.

2. Discussion

Hunting and poaching are the greatest causes of mortality in pronghorn species in most areas. Predation by coyotes (Canis latrans), bobcats (Felis rufus), and golden eagles (Aquila chrysaetos) have a marked effect on fawn survival (Kitchen and O'Gara 1982). Coyote predation on fawns has been the predominant cause of fawn mortality on Anderson Mesa, Arizona for more than 30 years (Neff and Woolsey 1979). Several diseases and parasites have been diagnosed in the pronghorn species: epizootic hemorrhagic disease, blue tongue, necrobacillus, vibrioses and nematodes, cestodes, trematodes and ticks are some of the diseases or parasites found on or in pronghorn.

Of the 12 Sonoran pronghorn carcasses collected, two were collected for the type specimen, four were poached, one drowned, one was road-killed, one was killed by coyotes, and three died of unknown causes. Hornaday's Expedition collected two or three specimens that were mounted and are privately owned in Tucson. The carcasses of seven Sonoran pronghorn poached in 1984 in Mexico were not recovered for cataloging.

Cause of fawn mortality is unknown with predation by coyotes being strongly suspected. During aerial location flights, coyotes were frequently observed near the pronghorn herds. In April 1985, doe #149.081 was observed chasing a coyote; one week later she was observed with fawns.

XIII ASSESSMENTS AND RECOMMENDATIONS

A. General Assessment

1. Population

The Sonoran pronghorn antelope is considered a separate subspecies based on geographical, morphological, and behavioral differences. Six skulls (two does and four bucks) have been examined and measured. Goldman (1945) and Paradiso and Nowak (1971) conclude that the measurements and cranial differences warrant a subspecies classification. The Arizona Game and Fish Department (1981) concluded that the measurements fall within the range of extremes for the four subspecies of pronghorn and that, until more skulls could be studied, a subspecies classification was not warranted.

Although numbers in the thousands were once observed, the U.S. population has remained at approximately 100 Sonoran pronghorn, and the Mexican population has dropped from 500-600 Sonoran pronghorn to 50-100 pronghorn in the last 75 years and currently is estimated to be 33-93. There are no apparent large-

scale population movements across the International Boundary. The reason for the decline in numbers is a degradation of habitat due to overgrazing and drying of the Gila and Sonoyta rivers, and the practice of poaching (Carr 1972). In 1967, the Sonoran pronghorn was placed on the USFWS Threatened and Endangered Species list.

The Sonoran pronghorn are found in the broad alluvial valleys on CPNWR, OPCNM, and LAFBGR in the U.S. Low foothills and bajadas are frequently used during the spring and winter months. They appear to be opportunistic feeders and drinkers, taking advantage of what is available on a seasonal basis.

2. Habitat

The Sonoran pronghorn range is in the lower southwest portion of Arizona and the northwestern part of the state of Sonora, Mexico. Sonoran pronghorn use the broad, flat valleys between north/south directional mountain ranges. Prior to the conversion of the area to a refuge, national monument and gunnery range between 1937 and 1940, cattle grazing and mining were the primary activities in the region. All cattle were removed by early 1980s and mining was completely halted in the 1970s. The habitat is still recovering from the overgrazing.

Ranchers dug wells and erected windmills and troughs. These still remain and the CPNWR has reopened and developed other wells and tanks since 1978. OPCNM has maintained several ranching

wells within the Sonoran pronghorn's range, and the AGFD maintains catchments on the LAFBGR.

Human activity is minimal in this region and confined to administrative roads on OPCNM and CPNWR. The military conducts air-to-air and air-to-ground ordinance delivery, but impact is minimal and confined to six ranges.

B. Threats

1. Population

Humans still pose a threat to the Sonoran pronghorn. Poaching still occurs in Mexico but is minimal in the U.S. due to different law enforcement practices. Human activity on the Sonoran pronghorn range creates minimal disturbances to the herds and does not pose any long-term threat since activity is greatly restricted by the land managing agencies.

Coyotes, bobcats, and possibly mountain lions are the only potential Sonoran pronghorn predators in the region. Coyote predation has been documented during the study, and several collared Sonoran pronghorn have had a coyote observed within 1.7 km of their herds. During the 1960s, Compound 1080 was used as a predator control agent, with no apparent benefit to the Sonoran pronghorn (AGFD 1981).

2. Habitat

The major threat to the habitat (cattle) was removed in the early 1980's. The combined effect of cattle grazing and drying of the rivers in the region resulted in a degradation of forage quality and abundance. Shortage of permanent water sources continues today, but water development is relieving some of the pressure to the wildlife. Investigations are currently being conducted by AGFD and USFWS to evaluate pronghorn use of a newly developed water source.

Another threat to the habitat is off-road travel. Off-road travel is prohibited, yet does occur on the gunnery range. Off-road travel by ordinance personnel and by trespass civilians occurs infrequently on CPNWR and OPCNM.

C. Existing Management

1. Population

The Sonoran pronghorn is listed as endangered and is federally protected. Hunting of the subspecies was prohibited in 1922 in the U.S. Management is mainly custodial and conducted by refuge personnel and park service employees. Prior to this study, surveys were regularly conducted by AGFD and USFWS personnel. Records are kept on all observations and both agencies promote public awareness of the protected status of the Sonoran pronghorn and its habitat.

2. Habitat

The range of the Sonoran pronghorn is managed primarily by three agencies (USFWS, USNPS and USAF). A dozen other agencies have input in the various studies, inventories, and land use of the region. All three agencies restrict human activity in the area; CPNWR and OPCNM prohibit off-road driving and large portions of their land holdings are inaccessible to most people. LAFB limits public use on the gunnery range to a few hunting days (for other game species) in the fall. Travel in all three areas is restricted to administrative roads. This keeps disturbance to the habitat at a minimum.

Water hole development and maintenance is performed by OPCNM and CPNWR on their lands, and by the AGFD on the military range. Water is hauled to the catchments; windmills and tanks are periodically checked to maintain the water level at half full or more.

With the habitat alteration caused by a variety of impacts within the Sonoran pronghorn's range during the last 100 years, it is not known what the present-day optimum for vegetation is in the region. Both CPNWR and OPCNM are documenting the recovery of the habitat from overgrazing. CPNWR is currently conducting a series of vegetation transects in the Cameron Charco area, once a heavily grazed section of the refuge. This documentation of recovery will provide a baseline for determining forage quality and availability for the Sonoran pronghorn.

D. Proposed Management

1. Population

In 1982, a recovery plan was drafted by the Sonoran Pronghorn Recovery Team for protection of the Sonoran pronghorn and habitat. It proposed a plan for maintaining existing population numbers and distribution, and increasing the U.S. population to 300 animals (averaged over a five-year period) or numbers feasible for the habitat. Once this number is met and major threats are reduced, the subspecies would be considered for delisting. Several problems would be encountered with this plan. Mexican recovery objectives and methods would have to be different due to the exploitation of Sonoran pronghorn and different law enforcement practices. There is also no clear means of increasing the population, except by habitat protection. Congress is currently considering a wilderness designation for a large portion of the CPNWR. This could restrict vehicular travel through portions of the refuge. However, this could make it more difficult to maintain wells and catchments within the Sonoran pronghorn's range.

Several water sources are currently being considered for development or redevelopment on the refuge. These wells are within known home ranges of collared Sonoran pronghorn.

2. Conservation Recommendations

Habitat protection and improvement are critical in maintaining the Sonoran pronghorn's current distribution. There are several projects that need to be implemented to maximize the recovery potential for this subspecies:

a. Continue to remove trespass domestic livestock that are found on any of the area used by Sonoran pronghorn. This is being done not only to enhance the vegetative recovery of the range but to reduce the possibility of introducing domestic livestock disease that could lead to an epizootic.

b. Prior to continued water development designed specifically for Sonoran pronghorn, the study of the Aguila Mountain Catchment should be completed. If it appears that a net benefit to pronghorn can be derived, the program of water development should be continued.

c. Until the carcasses of the three Sonoran pronghorn collected on this study have been reviewed for taxonomic assignment, the current legal status of the Sonoran pronghorn should be maintained.

d. In view of the insight gained into the current status of the Sonoran pronghorn during this study,

collared Sonoran pronghorn should be fitted with new telemetry equipment and the study should continue to be funded until September 30, 1989. This would allow refinement of many of the data collected to date. The use of satellite telemetry should be considered, and, if feasible, included in any further study.

e. No major new impacts into areas utilized by Sonoran pronghorn should be allowed within 10 km of a permanent water source. Examples of this would be military impact or target areas. Impacts such as new roads should be routed to avoid permanent water sources.

f. Any changes in status of the range (i.e. wilderness status) should recognize that water developments may be important to Sonoran pronghorn and maintenance should be a permitted activity.

g. The direction for the current study needs to be changed to include efforts to determine the reason pronghorn make repeated long range movements. This redirection should include forage quality studies.

Literature Cited

Asdell, S.A. 1946. Patterns of mammalian reproduction. Comstock Publishing Co. Ithaca, New York.

Arizona Game and Fish Commission. 1982. Threatened native wildlife in Arizona. Ariz. Game and Fish Dept. Publ.

Arizona Game and Fish Department. 1981. The Sonoran pronghorn. Special Report #10. Project W-53-R. Work Plan 1, Job 1. Ariz. Game and Fish Dept.

Autenrieth, R.E., G.L. Copeland, and T. Reynolds. 1981. Capturing pronghorn antelope using the helicopter and M-99. J. Wildl. Manage.

Barrett, M.W., J.W. Nolan, and L.D. Roy. 1982. Evaluation of a hand-held net-gun to capture large mammals. Wildl. Soc. Bull. 10:108-114.

Beale, D.M. and A.D. Smith. 1970. Forage use, water consumption and productivity of pronghorn antelope in western Utah. J. Wildl. Manage. 34(3):570-582.

Brown, D.E. (editor). 1982. Biotic communities of the American Southwest United States and Mexico. Desert Plants 4 (numbers 1-4).

Carr, J.N. 1969. Completion Report - Endangered species investigation, Sonoran Pronghorn pp1-5. Ariz. Game and Fish Dept.

_____. 1970. Progress Report - Endangered species investigation, Sonoran Pronghorn pp203-207. Ariz. Game and Fish Dept.

_____. 1971. Progress Report - Endangered species investigation, Sonoran Pronghorn pp247-262. Ariz. Game and Fish Dept.

_____. 1972. Progress Report - Endangered species investigation, Sonoran Pronghorn pp1-9. Ariz. Game and Fish Dept.

_____. 1973. Performance Report - Endangered species investigation, Sonoran Pronghorn pp1-11. Ariz. Game and Fish Dept.

Chalmers, G.A. and M.W. Barrett. 1977. Capture myopathy in pronghorns in Alberta, Canada. J. Am. Vet. Med. Assoc. 171:918-923.

Copeland, G.L., R.E. Autenrieth, R.E. Oddenburg, and T.P. Kistner. 1978. Tranquilizing pronghorns with M-99 from a helicopter. In: Proceedings of the Eighth Biennial Pronghorn Antelope Workshop. pps 94-109.

deVos, J.C. Jr., C.R. Miller, and W.D. Ough. 1984. An evaluation of four methods to capture mule deer in Arizona. In: Deer of the southwest: a symposium. School of Renewable Natural Resources, University of Arizona, Tucson Arizona.

ESRI. 1986. ARC/info users manual. Environmental Systems Research Institute. Redlands, Calif.

Halloran, A.F. 1957. A note on Sonoran pronghorn. J. Mammal 38 (3):423.

Isaacs, C. 1982. Far West Humane Animal Capture, Mesa, Arizona.

Goldman, E.A. 1945. A new pronghorn from Sonora. Proc. Biol. Soc. Washington. 58:3-4.

Gonzalez-Romero, A. and A. La Fon Terrazas. 1985. Situacion actual del berrendo Antilocapra americana en Mexico: un estudio prospectivo. Instituto de Ecologia, A.C. ala Direccion de Flora y Fauna Terrestres. pp 1-31.

Kitchen, D.W. 1974. Social behavior and ecology of the pronghorn. Wildlife Monogr. 38:1-96.

_____ and Bart W. O'Gara. 1982. Pronghorn (Antilocapra americana) wild mammals of North America. Johns Hopkins University Press.

LeCount, A., and W.K. Carrell. 1979. Removable rotary antenna handle for aerial radio tracking. Fed. Aid Wildl. Res. Project W-78-R-20 Research Division Ariz. Game and Fish Dept. Memo.

Lucas, H.A. and C.A.F. Seber. 1977. Estimating coverage and particle density using the line intercept method. Biometrika 64:618-622.

MacArthur, R.H. and J.W. MacArthur. 1961. Vegetation analysis technique/Board Technique on bird species diversity. Ecol. 42:594-598.

Miller, F. L., D.F. Brehend, and G.D. Tessier. 1971. Live capture of barren ground caribou with tangle nets. N.E. Sect. Wildl. Soc. Trans. 28:83-90.

Monson, G. 1968. The desert pronghorn. Desert Bighorn Council Transactions. pp 63-69.

National Park Service. 1977. Natural and cultural resources management plan and environmental assessment. Organ Pipe Natl. Monu., Arizona. pp 29-47.

_____. No date. Statement for management. Organ Pipe Natl. Monu., Arizona.

_____ and UofA. 1981. Vegetation of Organ Pipe Cactus National Monument. Technical Report No. 8. Office of Arid Lands Studies. UofA, Tucson, Arizona.

Nations, D. and E. Stump. 1981. Geology of Arizona. Kendall/Hunt Publishing Co.

Natural Resource Planning Team, UofA. 1984. Natural resource management planning for Luke Air Force Range, Phase 1. College of Agriculture, School of Renewable Natural Resources, UofA. Tucson, Arizona.

Neff, D.J. and N. Woolsey. 1979. Effect of Predation by coyotes on antelope fawn survival on Anderson Mesa. Special Report #8, Ariz. Game & Fish Dept., pp 1-36.

Nelson, E.W. 1925. Status of the pronghorned antelope, 1922-1924. U.S. Dept. of Agric. Bull. 1346:64.

Nichol, A.A. 1941. Game reconnaissance of southwestern Arizona, south of the Gila River. Unpubl., Ariz. Game and Fish Dept.

Norusis, M.J. 1985. SPSS-X, Advanced statistics guide. McGraw Hill, New York. 505 pp.

Paradiso, J.L. and R.M. Nowak. 1971. Taxonomic status of the Sonoran Pronghorn. J. Mammal. 52(4):855-858.

Phelps, J.S. 1974. Performance Report - Endangered species investigation, Sonoran Pronghorn. Ariz. Game and Fish Dept.

Sellers, W.D. and R.H. Hill. 1974. Arizona climate 1931-1972. UofA Press, Tucson, Arizona. Second Edition.

Shreve, F. and I.L. Wiggins. 1964. Vegetation and flora of the Sonoran desert. Vols. I and II. Stanford University Press, Stanford, CA.

Smith, R. and R. Horejsi. 1982. Wildlife Digest-a field test of the net gun to capture mule deer. Abstract number 13, June 1982, Arizona Game and Fish Department, Phoenix, Arizona.

Sokal, R.R. and F.J. Rohlf. 1969. Biometry. W.H. Freeman and Co., San Francisco. 776 pp.

Spillett, J.J. and R.S. Zobell. 1967. Innovations in trapping and handling pronghorn antelope. J. Wildl. Manage. 31(2):347-351.

Sundstrom, C. 1968. Water consumption by pronghorn antelope and distribution related to water in Wyoming's Red Desert. Proc. Antelope States Workshop 3:39-46.

U.S. Fish and Wildlife Service. 1982. Sonoran pronghorn recovery plan. U.S. Fish & Wildlife Service, Albuquerque, New Mexico.

_____. 1983. Endangered and threatened wildlife and plants. 50 CFR 17.11 and 17.12.

_____. 1984. Code of Federal Regulations. Title 50, Chapter 1, Parts 1 to 199. Office of Federal Register, National Archives and Records Service.

Villa, R.B. 1958. Partial account of Prof. Bernardo Villa R. concerning the study of bighorn sheep and antelope in northern Mexico. Instituto de Biologia, Mexico, D.F. Unpubl.

Wallace, A. (editor). 1965. Pumpelly's Arizona. An excerpt from "Across America and Asia" by Raphael Pumpelly. The Palo Verde Press, Tucson, Arizona.

Appendix 1. Data collected during aerial observations on ten collared Sonoran pronghorn, October 1983 to October 1985. C/B = creosote/bursage association; baj = bajada.

Animal #	Date	Distance Moved	Days Between	Herd Size	Vegetation Type	UTM Coordinates
149.081	11/05/83			7	C/B	3-06.3Ex35-49.1N
	11/19/83	20.5 K	14	7	C/B	2-99.1Ex35-68.3N
	03/04/84	5.6	15		C/B	3-01.3Ex35-63.1N
	03/30/84	9.9	26		C/B	2-93.1Ex35-68.7N
	03/31/84	14.6	1		Wash	2-97.1Ex35-82.7N
	05/28/84	11.2	58	7	baj	3-04.6Ex35-74.1N
	06/16/84	12.9	19		C/B	2-93.1Ex35-67.7N
	06/23/84	10.7	7		Wash	2-87.9Ex35-77.1N
	08/04/84	9.9	42		Wash	2-96.1Ex35-82.7N
	08/18/84	2.0	14		Wash	2-97.5Ex35-81.3N
	08/25/84	1.8	7	1	C/B	2-95.7Ex35-80.9N
	09/01/84	16.1	7		C/B	3-00.1Ex35-65.5N
	09/08/84	5.9	7		Wash	2-95.5Ex35-68.7N
	09/15/84	8.0	7		Wash	2-98.9Ex35-75.9N
	09/22/84	1.7	7	7	C/B	2-97.3Ex35-75.3N
	09/29/84	8.0	7	6	C/B	2-94.7Ex35-82.9N
	10/06/84	4.5	7	6	C/B	2-92.7Ex35-86.9N
	10/27/84	22.1	21		C/B	2-99.5Ex35-65.9N
	11/11/84	23.0	15	8	C/B	2-89.3Ex35-86.5N
	11/17/84	10.4	6	8	C/B	2-95.7Ex35-78.3N
	11/24/84	13.7	7	9	baj	3-06.3Ex35-69.7N
	12/09/84	7.4	15			2-98.9Ex35-69.1N
	12/15/84	4.8	6	21	C/B	3-01.9Ex35-65.3N
	12/22/84	3.9	7	8	C/B	2-98.3Ex35-66.3N
	12/30/84	1.4	8	10	C/B	2-99.5Ex35-67.5N
	01/05/85	1.8	6	16	C/B	3-00.3Ex35-65.9N
	01/12/85	1.8	7	7	C/B	2-98.5Ex35-65.5N
	02/10/85	3.2	29	3	C/B	3-01.7Ex35-65.7N
	02/16/85	10.2	6	6	baj	3-02.3Ex35-75.9N
	03/09/85	12.2	21	1	C/B	2-91.7Ex35-81.9N
	03/16/85	5.3	7	3	C/B	2-96.9Ex35-80.4N
	04/07/85	11.5	22	1	C/B	2-98.7Ex35-69.5N
	04/14/85	4.0	7	3	C/B	3-01.1Ex35-66.3N

Appendix 1. continued

149.081	04/20/85	1.2	6	4	C/B	3-01.3Ex35-65.1N
	05/11/85	5.0	21		C/B	3-05.9Ex35-67.1N
	05/18/85	1.2	7		C/B	3-04.9Ex35-67.7N
	06/08/85	8.0	21		Wash	3-02.5Ex35-75.3N
	06/15/85	5.5	7	12	Wash	3-04.9Ex35-70.3N
	06/23/85	1.0	7	2	C/B	3-05.9Ex35-70.1N
	06/29/85	2.5	6	4	baj	3-06.7Ex35-72.5N
	07/06/85	8.6	7	3	baj	3-07.1Ex35-63.9N
	07/27/85	2.8	21		Wash	3-09.9Ex35-64.1N
	08/17/85	5.2	7	2	baj	3-07.1Ex35-68.3N
	08/24/85	.9	7	8	baj	3-06.3Ex35-68.9N
	08/31/85	4.0	7	14	baj	3-08.1Ex35-65.3N
	09/07/85	3.3	7		baj	3-06.3Ex35-68.1N
	09/14/85	25.5	7	8	C/B	2-90.7Ex35-88.3N
	09/22/85	2.9	8	5	C/B	2-92.3Ex35-85.9N

Animal #	Date	Distance Moved	Days Between	Herd Size	Vegetation Type	UTM Coordinates
149.201F	11/05/83			7	C/B	2-71.9Ex35-96.4N
	11/19/83	6.3 K	14	5	C/B	2-73.9Ex36-02.1N
	03/30/84	9.0	141		C/B	2-71.3Ex35-93.5N
	05/28/84	21.2	58	4	C/B	2-84.7Ex35-77.1N
	06/23/84	15.5	26		Hill	3-00.1Ex35-75.3N
	08/04/84	42.1	42		C/B	2-59.3Ex35-85.5N
	08/25/84	24.4	21		C/B	2-68.1Ex36-08.3N
	09/01/84	14.7	7	3	C/B	2-73.1Ex35-94.5N
	09/08/84	7.7	7		C/B	2-77.1Ex36-01.1N
	09/15/84	5.8	7		C/B	2-72.7Ex35-97.3N
	09/22/84	2.4	7		C/B	2-72.3Ex35-99.7N
	09/29/84	8.1	7	5	C/B	2-75.1Ex35-92.1N
	10/06/84	2.4	7	4	C/B	2-73.3Ex35-93.7N
	10/27/84	7.9	21	6	baj	2-65.9Ex35-96.5N
	11/11/84	7.7	15	7	C/B	2-73.5Ex35-95.5N
	11/17/84	3.4	6	5	C/B	2-70.1Ex35-95.5N
	11/24/84	5.1	7	8	C/B	2-75.1Ex35-94.5N
	12/09/84	31.0	15			2-51.9Ex36-15.1N
	12/15/84	16.1	6	7	C/B	2-57.3Ex35-99.9N

Appendix 1. continued

Animal #	Date	Distance Moved	Days Between	Herd Size	Vegetation Type	UTM Coordinates
149.201F	12/22/84	20.4	7	7	Wash	2-77.7Ex36-00.1N
	12/30/84	13.9	8	7	baj	2-63.9Ex36-01.3N
	01/05/85	6.4	6	8	C/B	2-59.1Ex36-05.6N
	01/12/85	15.2	7	8	C/B	2-74.1Ex36-03.1N
	02/10/85	16.3	29	8	baj	2-57.9Ex36-05.1N
	02/16/85	8.5	6	7	C/B	2-66.1Ex36-07.5N
	03/09/85	15.4	21	3	C/B	2-72.1Ex35-93.3N
	03/16/85	9.0	7	1	C/B	2-73.9Ex36-02.1N
	04/14/85	10.9	29	1	Wash	2-66.5Ex35-94.1N
	04/20/85	8.1	6	1	C/B	2-74.4Ex35-92.4N
	05/11/85	7.5	21		C/B	2-80.5Ex35-88.1N
	05/18/85	.4	7		C/B	2-80.5Ex35-88.5N
149.250F	11/05/83			5	baj	3-15.1Ex35-72.9N
	11/19/83	5.0 K	14	4	Wash	3-16.5Ex35-68.1N
	03/04/84	4.5	115	4	baj	3-16.7Ex35-72.7N
	05/28/84	3.2	84	3	baj	3-17.1Ex35-69.5N
	06/23/84	.6	26		Wash	3-16.7Ex35-69.1N
	07/14/84		21		C/B	3-15.3Ex35-71.7N
	08/04/84	1.3	21		C/B	3-16.3Ex35-72.5N
	08/18/84	.6	14		C/B	3-16.9Ex35-72.3N
	08/25/84	9.9	7		Wash	3-24.5Ex35-65.9N
	09/01/84	3.5	7		Wash	3-21.1Ex35-65.1N
	09/08/84	8.0	7		Wash	3-16.5Rc35-71.1N
	09/15/84	2.3	7		Wash	3-18.1Ex35-70.1N
	09/22/84	1.0	7	7	C/B	3-17.1Ex35-70.1N
	09/29/84	.4	7	5	C/B	3-17.1Ex35-70.5N
	10/06/84	.4	7	7	C/B	3-17.5Ex35-70.3N
	10/27/84	1.1	21		baj	3-16.5Ex35-69.7N
	11/11/84	3.6	15	7	Hill	3-15.3Ex35-73.1N
	11/17/84	3.2	6	7	baj	3-17.1Ex35-70.5N
	11/24/84	1.3	7	7	baj	3-16.3Ex35-69.5N
	12/09/84	3.7	15		Wash	3-14.7Ex35-72.8N
	12/15/84	4.0	6	7	Wash	3-16.9Ex35-69.5N

Appendix 1. continued

Animal #	Date	Distance Moved	Days Between	Herd Size	Vegetation Type	UTM Coordinates
149.250F	12/22/84	1.3	7	7	Hill	3-16.3Ex35-68.3N
	12/30/84	4.8	8	7	baj	3-14.9Ex35-72.9N
	01/05/85	1.8	6	7	Hill	3-14.9Ex35-74.7N
	01/12/85	2.2	7	7	C/B	3-14.9Ex35-72.5N
	02/10/85	3.4	29	6	Hill	3-17.3Ex35-70.1N
	02/16/85	8.9	6		Hill	3-12.1Ex35-77.3N
	03/02/85	.3	14	2	Hill	3-11.9Ex35-77.1N
149.260F	11/05/83			7	C/B	2-71.9Ex35-96.1N
	11/19/83	6.3	14	5	C/B	2-73.9Ex36-02.1N
	03/04/84	1.7	115		C/B	2-72.3Ex36-01.5N
	03/30/84	8.1	26		C/B	2-88.9Ex35-54.7N
	05/28/84	42.6	58	4	baj	2-71.3Ex35-93.5N
	06/16/84	4.1	19		Wash	2-84.9Ex35-53.9N
	06/23/84	2.2	7		Wash	2-86.7Ex35-55.1N
	07/14/84	3.2	21		Wash	2-89.9Ex35-55.3N
	08/04/84	16.2	21		C/B	2-90.5Ex35-71.5N
	08/18/84	7.4	14		Wash	2-84.9Ex35-66.7N
	08/25/84	5.6	7	6	C/B	2-88.1Ex35-71.3N
	09/01/84	10.0	7		C/B	2-78.7Ex35-67.9N
	09/08/84	3.7	7		Wash	2-77.9Ex35-79.7N
	09/15/84	17.0	7		Wash	2-78.7Ex35-62.7N
	09/22/84	9.7	7		C/B	2-73.3Ex35-54.7N
	09/29/84		7	5	C/B	2-78.9Ex35-63.5N
	10/06/84	11.5	7	6	C/B	2-78.3Ex35-65.1N
	11/11/84	30.8	35	7	C/B	2-73.5Ex35-95.5N
	11/17/84	5.4	6	1	C/B	2-74.1Ex36-00.9N
	11/24/84	1.4	7	8	C/B	2-75.1Ex35-94.5N
	12/09/84	31.0	15			2-51.9Ex36-15.1N
	12/15/84	16.1	6	7	C/B	2-57.3Ex35-99.9N
	12/22/84	20.4	7	7	Wash	2-77.7Ex36-00.1N
	12/30/84	13.9	8	7	baj	2-63.9Ex36-01.3N
	01/05/85	6.4	6	8	C/B	2-59.1Ex36-05.6N
	01/12/85	15.2	7	8	C/B	2-74.1Ex36-03.1N

Appendix 1. continued

Animal #	Date	Distance Moved	Days Between	Herd Size	Vegetation Type	UTM Coordinates
149.260F	02/10/85	16.3	29	8	Hill	2-57.9Ex36-05.1N
	02/16/85	8.5	6	7	C/B	2-66.1Ex36-07.5N
	03/16/85	37.4	28	1	C/B	2-72.9Ex35-70.7N
	04/14/85	2.0	29	1	Wash	2-61.3Ex35-87.3N
	04/20/85	33.4	6	1	C/B	2-81.3Ex35-60.5N
	05/04/85	6.1	14		baj	2-84.9Ex35-55.5N
	05/11/85	15.4	7	7	C/B	2-84.5Ex35-70.9N
	05/18/85	5.6	7		C/B	2-84.1Ex35-65.3N
	06/15/85	11.5	28	1	baj	2-86.5Ex35-54.1N
	06/23/85	2.3	8	4	baj	2-88.7Ex35-54.7N
	06/29/85	.8	6	4	baj	2-87.9Ex35-54.7N
	07/06/85		8	6	baj	2-86.7Ex35-54.1N
	07/27/85	9.9	21	4	C/B	2-83.7Ex35-63.7N
	08/17/85	5.2	21	8	C/B	2-79.5Ex35-60.7N
	08/24/85	6.0	7	2	C/B	2-83.1Ex35-55.9N
	08/31/85	1.0	7	7	C/B	2-82.5Ex35-56.7N
	09/07/85	4.9	7	12	C/B	2-80.3Ex35-61.1N
	09/14/85	8.9	7	5	Hill	2-86.5Ex35-54.7N
	09/22/85	.6	8	6	Hill	2-86.5Ex35-54.1N
149.290F	11/05/83			5	baj	3-15.1Ex35-72.9N
	11/19/83	5.0 K	14	4	Wash	3-16.5Ex35-68.1N
	03/04/84	4.6	115	4	baj	3-16.7Ex35-72.7N
	05/28/84	3.2	85	3	baj	3-12.1Ex35-71.5N
	06/23/84	.6	26		Wash	3-16.7Ex35-69.1N
	07/14/84		21		C/B	3-16.5Ex35-68.5N
	08/04/84	1.3	21		C/B	3-16.3Ex35-72.5N
	08/18/84	.6	14		C/B	3-16.9Ex35-72.3N
	08/25/84	9.9	7		Wash	3-24.5Ex35-65.9N
	09/01/84	3.5	7		Wash	3-21.1Ex35-65.1N
	09/08/84	8.0	7		Wash	3-16.5Ex35-71.7N
	09/15/84	2.3	7		Wash	3-18.1Ex35-70.1N
	09/22/84	1.0	7	7	C/B	3-17.1Ex35-70.1N
	09/29/84	.4	7	5	C/B	3-17.1Ex35-70.5N

Appendix 1. continued

Animal #	Date	Distance Moved	Days Between	Herd Size	Vegetation Type	UTM Coordinates
149.290F	10/06/84	.4	7	7	C/B	3-17.5Ex35-70.3N
	10/27/84	1.1	21		baj	3-16.5Ex35-69.7N
	11/11/84	3.6	15	7	Hill	3-15.3Ex35-73.1N
	11/17/84	3.2	6	7	baj	3-17.1Ex35-70.5N
	11/24/84	1.3	7	7	baj	3-16.3Ex35-69.5N
	12/09/84	3.7	15		Wash	3-14.7Ex35-72.9N
	12/15/84	4.0	6	7	Wash	3-16.9Ex35-69.5N
	12/22/84	1.3	7	7	Hill	3-16.3Ex35-68.3N
	12/30/84	4.8	8	7	baj	3-14.9Ex35-72.9N
	01/05/85	1.8	6	7	Hill	3-14.6Ex35-74.7N
	01/12/85	2.2	7	7	C/B	3-14.9Ex35-72.5N
	02/10/85	3.4	29	6	C/B	3-17.3Ex35-70.1N
	02/16/85	8.0	6		Wash	3-12.5Ex35-76.5N
	05/04/85	6.7	77			3-15.5Ex35-70.5N
	05/18/85	5.3	14	1	C/B	3-19.9Ex35-67.5N
	06/08/85	6.1	21	2	Wash	3-14.1Ex35-69.5N
	06/15/85	1.7	7		baj	3-14.7Ex35-71.1N
	06/23/85	2.7	8	2	Hill	3-12.3Ex35-72.3N
	06/29/85	2.0	6	4	baj	3-11.5Ex35-74.1N
	07/06/85	5.0	7	6	Hill	3-14.9Ex35-70.5N
	07/27/85	1.6	21		Wash	3-15.9Ex35-69.3N
	08/17/85	3.4	21	7	baj	3-12.7Ex35-70.3N
	08/24/85	2.3	7	10	baj	3-12.1Ex35-72.5N
	08/31/85	5.8	7	7	baj	3-16.7Ex35-68.9N
	09/07/85	4.0	7	7	C/B	3-14.3Ex35-72.1N
	09/14/85	7.3	7	7	Hill	3-08.3Ex35-76.3N
	09/22/85	11.6	8	6	C/B	3-18.1Ex35-70.1N
	09/29/85	2.5	7	7	Hill	3-16.1Ex35-68.5N
149.311F	11/05/83				C/B	2-94.5Ex35-82.9N
	11/19/83	17.9	14	2	C/B	2-92.3Ex35-65.1N
	03/04/84	20.6	115		C/B	3-11.5Ex35-57.5N
	03/30/84	22.0	26		Wash	3-13.7Ex35-59.7N
	03/31/84	5.3	1		Wash	2-91.3Ex35-66.5N

Appendix 1. continued

149.311F	05/28/84	18.6	57	3	baj	2-95.5Ex35-63.3N
	06/16/84	2.1	19		Wash	3-11.7Ex35-60.3N
	06/23/84	1.5	7		Wash	3-10.3Ex35-60.7N
	07/14/84	4.9	21		Wash	3-05.5Ex35-61.5N
	08/04/84	5.7	21	3	C/B	3-00.3Ex35-63.9N
	08/18/84	3.9	14	4	C/B	2-97.1Ex35-66.1N
	08/25/84	2.1	7		C/B	2-98.5Ex35-64.5N
	09/01/84	3.2	7		C/B	3-00.1Ex35-61.7N
	09/08/84	7.0	7		C/B	2-95.7Ex35-67.1N
	09/15/84	4.2	7	5	C/B	2-98.7Ex35-64.1N
	09/22/84	4.9	7		C/B	2-94.1Ex35-65.7N
	09/29/84	3.2	7	6	C/B	2-92.3Ex35-63.1N
	10/06/84	5.0	7	4	C/B	2-95.9Ex35-66.5N
	10/27/84	6.0	21		C/B	2-99.7Ex35-61.9N
	11/11/84	1.6	15	9	C/B	2-98.1Ex35-62.1N
	11/24/84	8.8	13	5	C/B	2-93.7Ex35-69.7N
	12/09/84	5.2	15			2-98.9Ex35-69.1N
	12/15/84	4.8	6	21	C/B	3-01.9Ex35-65.3N
	12/22/84	9.6	7	6	C/B	2-92.3Ex35-65.5N
	12/30/84	7.0	8	7	C/B	2-99.1Ex35-67.1N
	01/05/85	1.7	6	16	C/B	3-00.3Ex35-65.9N
	01/12/85	7.3	7		C/B	2-93.3Ex35-63.7N
	02/10/85	8.4	29		C/B	3-01.7Ex35-63.9N
	02/16/85	2.4	6	4	C/B	2-99.3Ex35-65.5N
	03/02/85	13.5	14	5	C/B	3-12.1Ex35-59.7N
	03/09/85	3.4	7	1	C/B	3-13.1Ex35-56.5N
	03/16/85	.6	7	1	baj	3-13.7Ex35-56.5N
	04/07/85	1.0	22	3	baj	3-14.7Ex35-56.7N
	04/14/85	.7	7	7	baj	3-14.1Ex35-57.1N
	04/20/85	.8	6	4	baj	3-13.5Ex35-56.5N
	05/04/85	0.0	14		baj	3-13.5Ex35-56.5N
	05/11/85	.7	7		baj	3-13.1Ex35-57.1N
	05/18/85	1.1	7		baj	3-12.3Ex35-56.3N
	06/15/85	3.7	28		baj	3-15.9Ex35-57.3N
	06/23/85	4.5	78	6	Hill	3-11.9Ex35-59.3N
	06/29/85	2.4	6	4	Hill	3-13.5Ex35-57.5N
	07/06/85	.6	7	3	Hill	3-13.1Ex35-57.1N

Appendix 1. continued

149.311F	07/27/85	1.6	21	4	baj	3-12.1Ex35-55.9N
	08/17/85	3.8	21	4	baj	3-12.5Ex35-59.7N
	08/24/85	8.0	7	4	baj	3-12.5Ex35-67.7N
	08/31/85	11.7	7	4	C/B	3-05.1Ex35-58.7N
	09/07/85	4.7	7	3	C/B	3-01.9Ex35-62.1N
	09/14/85	1.3	7	3	C/B	3-03.1Ex35-61.7N
	09/22/85	3.0	8	16	C/B	3-06.1Ex35-61.5N
	09/29/85	4.7	7	5	C/B	3-10.5Ex35-59.9N

Animal #	Date	Distance Moved	Days Between	Herd Size	Vegetation Type	UTM Coordinates
149.100M	11/05/83			3	Wash	3-01.1Ex35-65.1N
	11/19/83	3.8	14	7	C/B	2-99.1Ex35-68.3N
	03/04/84	3.2	115		C/B	2-97.5Ex35-71.1N
	03/30/84	7.1	26		Wash	2-96.1Ex35-64.1N
	03/31/84	5.3	1		Wash	2-99.3Ex35-68.3N
	06/16/84	14.0	77		baj	3-12.5Ex35-63.7N
	06/23/84	2.0	7		Hill	3-14.3Ex35-62.9N

Animal #	Date	Distance Moved	Days Between	Herd Size	Vegetation Type	UTM Coordinates
149.221M	11/05/83				C/B	2-89.9Ex36-04.7N
	11/19/83	3.9	14	12	C/B	2-86.1Ex36-03.7N
	03/04/83	9.3	115		C/B	2-93.9Ex36-08.7N
	03/31/84	16.4	27		Hill	2-99.3Ex35-95.7N
	05/28/84	11.8	57		Hill	3-10.9Ex35-97.7N
	06/16/84	2.5	19		Wash	3-12.3Ex35-91.3N
	06/23/84	1.0	7		Wash	3-13.3Ex35-91.5N
	08/04/84	28.9	42		Wash	2-85.3Ex35-98.7N
	08/18/84		14		C/B	2-95.1Ex36-01.7N
	08/25/84	8.0	7		C/B	2-88.3Ex36.06.1N
	09/01/84	4.5	7		C/B	2-89.9Ex36.01.9N
	09/08/84	3.8	7		C/B	2-87.5Ex36.04.9N
	09/15/84	8.2	7	1	C/B	2-95.1Ex36.01.7N
	09/22/84	6.9	7		C/B	2-89.3Ex36.05.5N

Appendix 1. continued

Animal #	Date	Distance Moved	Days Between	Herd Size	Vegetation Type	UTM Coordinates
149.221M	09/29/84	3.1	7	2	C/B	2-88.5Ex36-08.5N
	10/06/84	5.7	7	3	C/B	2-89.3Ex36.02.9N
	10/27/84	7.9	21	6	C/B	2-90.5Ex35-95.1N
	11/11/84	9.2	15	1	baj	2-91.0Ex36-04.3N
	11/17/84	.8	6	1	C/B	2-89.3Ex36-02.5N
	11/24/84	6.3	7		baj	2-86.6Ex36-04.5N
	12/09/84	6.6	15		C/B	2-89.7Ex36-03.1N
	12/15/84	5.9	6	5	C/B	2-83.9Ex36-02.1N
	12/22/84	13.2	7	17	baj	2-97.1Ex36-01.5N
	12/30/84	.3	8	17	baj	2-97.3Ex36-01.7N
	01/05/85	3.4	6	10	C/B	2-97.5Ex36-05.1N
	01/12/85	1.6	7	17	C/B	2-97.3Ex36-06.7N
	02/10/85	14.2	29	9	C/B	2-83.3Ex36-04.5N
	02/16/85	5.4	6	1	C/B	2-88.7Ex36-04.7N
	03/02/85	5.3	14	1	C/B	2-90.5Ex36-99.7N
	03/09/85	7.2	7	3	C/B	2-84.1Ex36-02.9N
	03/16/85	4.6	7		C/B	2-88.7Ex36-02.3N
	04/07/85	6.2	21	1	C/B	2-86.1Ex36-07.9N
	04/14/85	7.7	7	1	C/B	2-90.3Ex36-01.5N
	04/20/85	2.7	6	1	C/B	2-88.3Ex35-99.7N
	05/04/85	.9	14		C/B	2-88.6Ex36-00.6N
	05/11/85	6.5	7	5	C/B	2-90.9Ex36-06.7N
	05/18/85	28.3	7		C/B	3-11.7Ex35-07.5N
	06/15/85	3.8	28		Hill	3-14.9Ex35-89.5N
	06/23/85	1.8	8	2	baj	3-13.7Ex35-90.9N
	06/29/85	1.3	6	3	C/B	3-12.5Ex35-90.3N
	07/06/85	8.1	7	1	baj	3-17.5Ex35-83.9N
	07/27/85	6.2	21	2	Hill	3-11.3Ex35-83.5N
	08/17/85	4.8	21		baj	3-12.7Ex35-78.9N
	08/24/85	1.1	7	4	baj	3-13.1Ex35-79.9N
	08/31/85	2.0	7	4	baj	3-11.1Ex35-80.3N
	09/22/85	37.3	22	7	C/B	2-88.1Ex36-09.7N
149.281M	11/05/83				C/B	2-89.9Ex35-66.7N

Appendix 1. continued

149.281M	11/19/83	5.1	14	9	C/B	2-87.3Ex35-71.1N
	03/30/84	11.2	141		Wash	2-96.1Ex35-64.1N
	05/04/84	27.3	58	1	lava flow	2-75.1Ex35-46.7N
	08/04/84	30.7	92		Hill	3-05.5Ex35-51.1N
	08/18/84	2.4	14		Wash	3-03.3Ex35-52.1N
	08/25/84	2.6	7	5	C/B	3-04.9Ex35-50.1N
	09/01/84	5.8	7		Wash	3-06.5Ex35-44.5N
	09/08/84	6.7	7		Hill	3-09.1Ex35-38.3N
	09/15/84	10.0	7		C/B	3-05.3Ex35-47.5N
	09/22/84	9.3	7		Hill	3-10.7Ex35-39.9N
	09/29/84		7	5	C/B	3-05.3Ex35-50.7N
	10/06/84	12.5	7	5	C/B	3-05.1Ex35-51.1N
	10/27/84	1.2	21	-	C/B	3-05.1Ex35-47.3N
	11/11/84	4.1	15	4	baj	3-09.1Ex35-48.3N
	11/17/84	3.6	6	5	Hill	3-05.5Ex35-48.5N
	11/24/84	1.7	7	5	Wash	3-06.5Ex35-47.1N
	12/09/84	2.3	15			3-06.9Ex35-49.3N
	12/15/84	.2	6	5	Hill	3-06.7Ex35-49.3N
	12/22/84	2.0	7	5	C/B	3-05.1Ex35-50.5N
	12/30/84	1.4	8	5	Hill	3-04.1Ex35-49.5N
	01/05/85	1.6	6	5	Hill	3-05.7Ex35-49.1N
	01/12/85	2.6	7	5	C/B	3-06.9Ex35-46.9N
	02/10/85	1.1	29	5	Hill	3-07.5Ex35-47.7N
	02/16/85	3.6	6	4	C/B	3-05.5Ex35-50.7N
	03/02/85	1.6	14	1	Hill	3-06.3Ex35-49.3N
	03/09/85	3.4	7	3	C/B	3-05.3Ex35-52.5N
	03/16/85	1.4	7	1	C/B	3-03.9Ex35-52.5N
	04/07/85	5.4	22	1	C/B	3-08.3Ex35-49.3N
	04/14/85	7.9	7		baj	3-02.5Ex35-43.9N
	04/20/85	6.7	6	1	baj	3-06.1Ex35-49.5N
	05/04/85	2.3	14		Hill	3-07.5Ex35-47.7N
	05/11/85	1.4	7		C/B	3-08.3Ex35-48.5N
	05/18/85	1.2	7	1	C/B	3-09.1Ex35-49.7N
	06/15/85	3.1	28	6	baj	3-07.7Ex35-46.9N
	06/23/85	2.2	8	6	baj	3-09.7Ex35-47.9N
	06/29/85	6.9	6	6	baj	3-05.1Ex35-42.7N
	07/06/85	7.5	14	6	baj	3-07.1Ex35-49.9N

Appendix 1. continued

Animal #	Date	Distance Moved	Days Between	Herd Size	Vegetation Type	UTM Coordinates
149.281M	07/27/85	8.6	21	6	baj	3-08.7Ex35-41.5N
	08/17/85	10.4	21	6	C/B	3-17.1Ex35-47.7N
	08/24/85	8.2	7	6	C/B	3-09.1Ex35-49.3N
	08/31/85	3.5	7	4	C/B	3-05.7Ex35-48.3N
	09/07/85	4.6	7	2	C/B	3-10.3Ex35-48.7N
	09/14/85	1.9	7	7	C/B	3-08.5Ex35-49.3N
	09/22/85	2.0	8	6	C/B	3-08.3Ex35-49.3N
	09/29/85	2.3	7	7	C/B	3-06.1Ex35-48.7N
149.380M	11/05/83			8	C/B	2-89.5Ex35-99.7N
	11/11/83	5.3	14	12	C/B	2-86.1Ex36-03.7N
	03/04/84	4.0	115		C/B	2-86.5Ex35-99.7N
	03/30/84	13.2	26		Hill	3-04.9Ex35-85.1N
	03/31/84	10.0	1		C/B	2-98.9Ex35-95.1N
	05/28/84	9.4	57		baj	2-95.5Ex35-85.7N
	06/23/84	.6	26		baj	3-04.3Ex35-84.9N
	08/04/84	3.7	42		baj	3-05.3Ex35-88.5N
	08/18/84	2.1	14		baj	3-06.7Ex35-90.1N
	08/25/84	13.4	7		baj	2-99.7Ex36-01.5N
	09/01/84	7.6	7		C/B	3-07.1Ex35-99.7N
	09/08/84	24.7	7		C/B	2-86.9Ex35-13.9N
	09/15/84	4.2	7	1	C/B	2-86.3Ex36-18.1N
	09/22/84	3.0	7		C/B	2-89.3Ex36-18.1N
	09/29/84	2.7	7	2	C/B	2-88.5Ex36-15.5N
	10/06/84	2.8	7	4	C/B	2-89.5Ex36-18.1N
	10/27/84	5.1	21	2	C/B	2-85.1Ex36-16.5N
	11/11/84	5.6	15	11	baj	2-81.7Ex36-29.9N
	11/17/84	24.2	16	10	C/B	2-90.3Ex35-97.3N
	11/24/84	18.4	7	10	C/B	2-89.1Ex36-15.7N
	12/22/84	12.9	28	6	Hill	2-79.5Ex36-07.1N
	01/05/85	14.8	14	6	C/B	2-83.1Ex36-21.5N
	01/12/85	5.8	7	6	C/B	2-77.7Ex36-23.7N
	02/10/85	20.0	29	9	C/B	2-83.3Ex36-04.5N
	02/16/85	2.4	6	3	baj	2-81.1Ex36-05.5N

Appendix 1. continued

149.380M	03/02/85	6.5	14	3	C/B	2-87.3Ex36-07.3N
	03/09/85	6.7	7	2	Hill	2-82.3Ex36-11.7N
	03/16/85	8.4	7	3	C/B	2-88.7Ex36-17.3N
	04/20/85	28.9	35	2	C/B	2-76.1Ex35-97.9N
	05/04/85	15.0	14		C/B	2-66.3Ex36-08.3N
	05/11/85	11.8	7		Hill	2-66.3Ex35-96.5N
	05/18/85	2.6	7	1	C/B	2-65.9Ex35-99.1N
	06/15/85	40.8	28		baj	3-04.1Ex35-84.9N
	06/23/85	9.0	8	3	baj	3-08.7Ex35-77.1N
	06/29/85	9.7	6	2	baj	3-04.1Ex35-85.7N
	07/06/85	0.0	7	1	baj	3-04.1Ex35-85.7N
	07/27/85	2.0	21	1	baj	3-05.5Ex35-84.3N
	08/17/85	12.6	21	2	baj	3-11.7Ex35-73.3N
	08/24/85	14.6	7	10	baj	3-05.1Ex35-86.3N
	08/31/85	2.1	7	9	Wash	3-04.5Ex35-88.3N
	09/07/85	2.9	7	3	Wash	3-03.9Ex35-85.5N
	09/14/85	10.7	7	3	C/B	2-93.9Ex35-86.7N
	09/22/85	13.4	8	5	C/B	2-87.1Ex35-98.3N

Appendix 2. Data collected during ground relocations on nine Sonoran pronghorn, October 1983 to October 1985.

Animal #	Sex	Date	Vegetation Type	Herd Size	Activity	UTM Coordinates
149.081	F	12/17/84	C/B	w/311		2-96.3Ex35-68.3N
149.100	M	07/13/84	Wash	Sol	Dead	3-14.7Ex35-61.7N
149.201	F	05/20/85	C/B	Sol	Dead	2-80.5Ex35-88.5N
149.221	M	03/30/84	C/B	Sol	Walk	2-83.5Ex36-00.1N
		06/07/84	Wash			3-13.5Ex35-93.5N
149.250	F	06/07/84	Wash	w/290		3-17.3Ex35-67.7N
		06/14/84	baj	Sol	Escape	3-16.9Ex35-72.3N
		06/21/84	baj	5 (w/290)	Browse	3-15.3Ex35-72.3N
		06/22/84	C/B	w/290		3-16.5Ex35-70.5N
		07/19/84	Wash	4 (w/290)	Browse; bed	3-18.7Ex35-71.1N
		07/26/84	baj	w/290		3-14.1Ex35-72.3N
		08/08/84	Wash	7 (w/290)	Escape; walk	3-15.3Ex35-72.7N
		08/09/84	baj	7 (w/290)	Walk	3-14.7Ex35-72.9N
		08/10/84	C/B	7 (w/290)	Browse	3-14.3Ex35-72.7N
		09/21/84	C/B	7 (w/290)	Escape	3-17.3Ex35-70.7N
		10/23/84	Wash	w/290		3-17.9Ex35-72.7N
		10/24/84	C/B	6 (w/290)	Browse; bed	3-16.9Ex35-71.1N
		11/02/84	C/B	6 (w/290)	At tank; escape	3-14.9Ex35-72.3N
		11/05/84	C/B	w/290		3-16.9Ex35-69.1N
		11/20/84	baj	5 (w/290	Browse	3-17.1Ex35-69.5N
		12/16/84	Wash	w/290	Bedded	3-16.5Ex35-69.1N
		02/23/85	baj	w/twins	Browse	3-11.5Ex35-78.1N
		02/26/85	baj	w/twins		3-11.7Ex35-77.7N
		02/28/85	baj	w/fawn	Escape	3-11.7Ex35-77.7N
		03/02/85	baj	w/fawn	Dead	3-11.9Ex35-77.1N
149.281	M	12/20/84	Wash			3-08.5Ex35-47.9N
		02/27/85	baj			3-07.1Ex35-45.1N
149.290	F	06/07/84	Wash	w/250		3-18.1Ex35-68.3N
		06/21/84	baj	5 (w/250)	Browse	3-16.7Ex35-71.9N
		06/22/84	C/B	w/250		3-16.5Ex35-70.5N
		07/12/84	Wash		Walk	3-18.1Ex35-69.1N
		07/19/84	Wash	4 (w/250)	Browse; bed	3-18.7Ex35-71.1N
		07/26/84	baj	w/250		3-14.1Ex35-72.3N

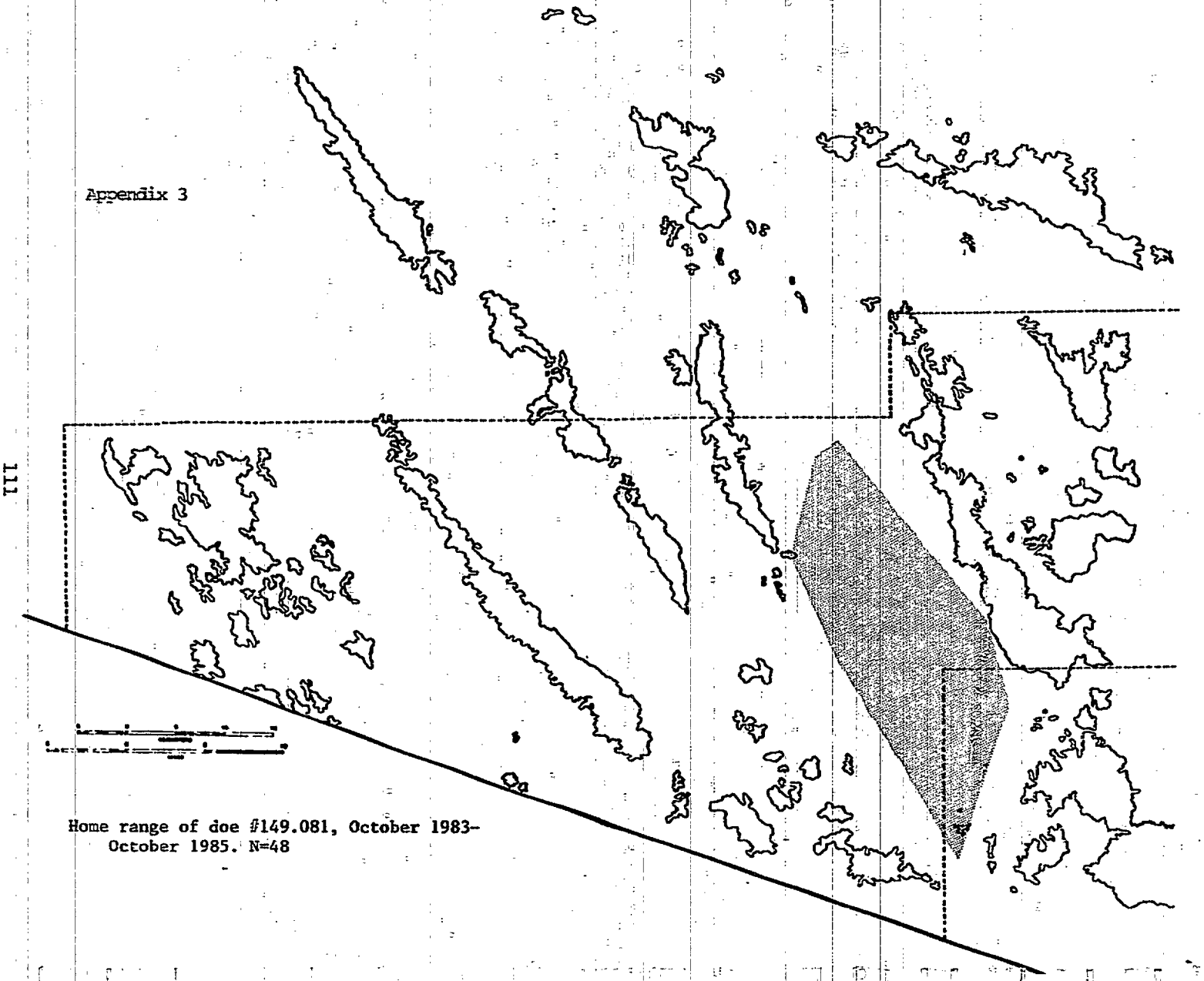
Appendix 2. continued

Animal #	Sex	Date	Vegetation Type	Herd Size	Activity	UTM Coordinates
		08/08/84	Wash	7 (w/250)	Escape; walk	3-15.3Ex35-72.7N
		08/09/84	baj	7 (w/250)	Walk	3-14.7Ex35-72.9N
		08/10/84	C/B	7 (w/250)	Browse	3-14.3Ex35-72.7N
		09/21/84	C/B	7 (w/250)	Escape	3-17.3Ex35-70.7N
		10/23/84	Wash	w/250		3-17.9Ex35-72.7N
		10/24/84	C/B	6 (w/250)	Browse; bed	3-16.9Ex35-71.1N
		11/05/84	C/B	w/250		3-14.9Ex35-77.3N
		11/20/84	baj	5 (w/250)	Browse	3-17.1Ex35-69.5N
		12/16/84	Wash	w/250	Bedded	3-16.5Ex35-69.1N
149.311	F	12/17/84	C/B	w/081		2-96.3Ex35-68.3N
149.380	M	03/30/84	C/B	Sol	Browse	2-90.5Ex35-94.9N
		06/15/84	baj			3-03.9Ex35-87.3N

Appendix 3

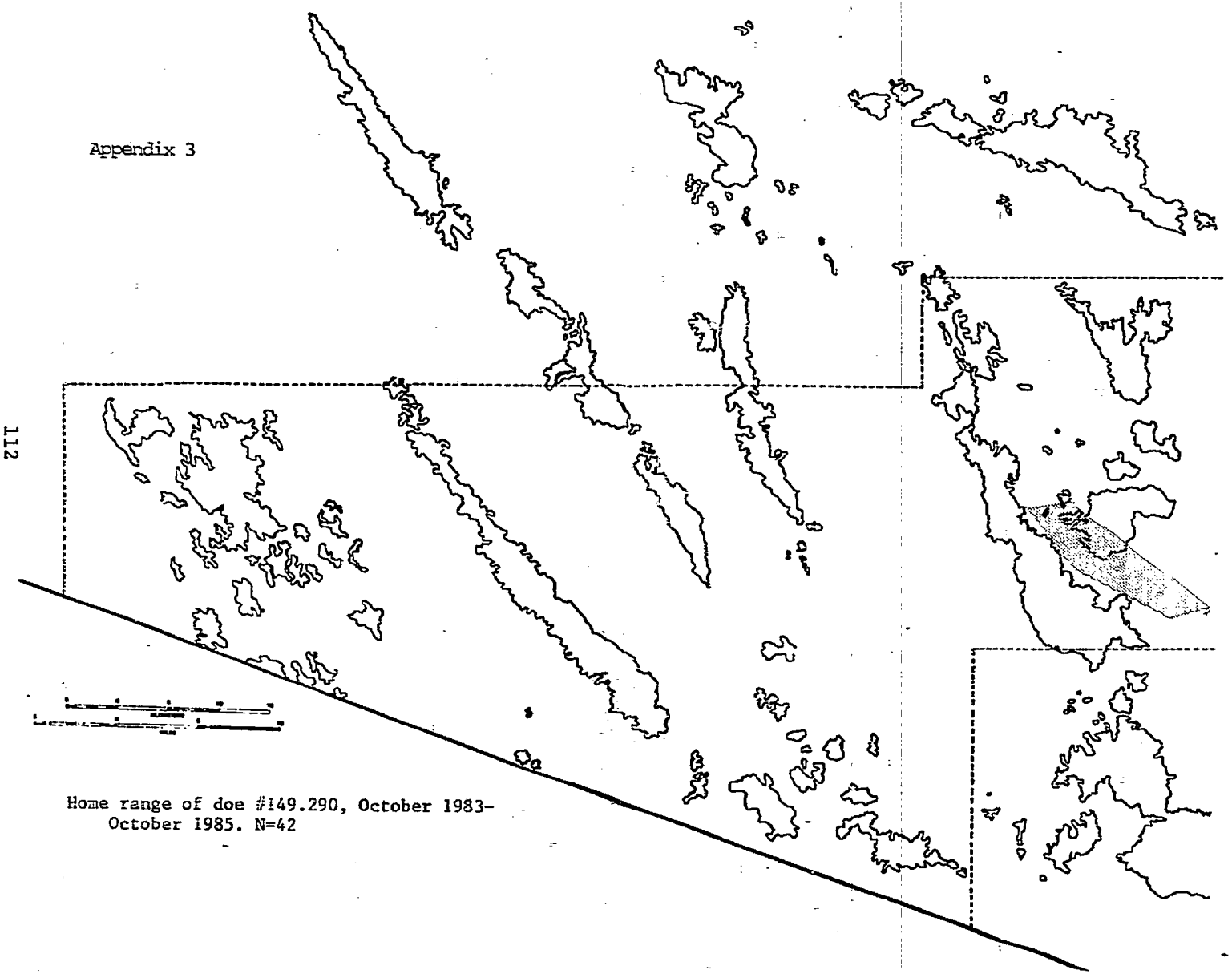
Home ranges of individual collared Sonoran pronghorn, October 1983 to October 1985.

Appendix 3



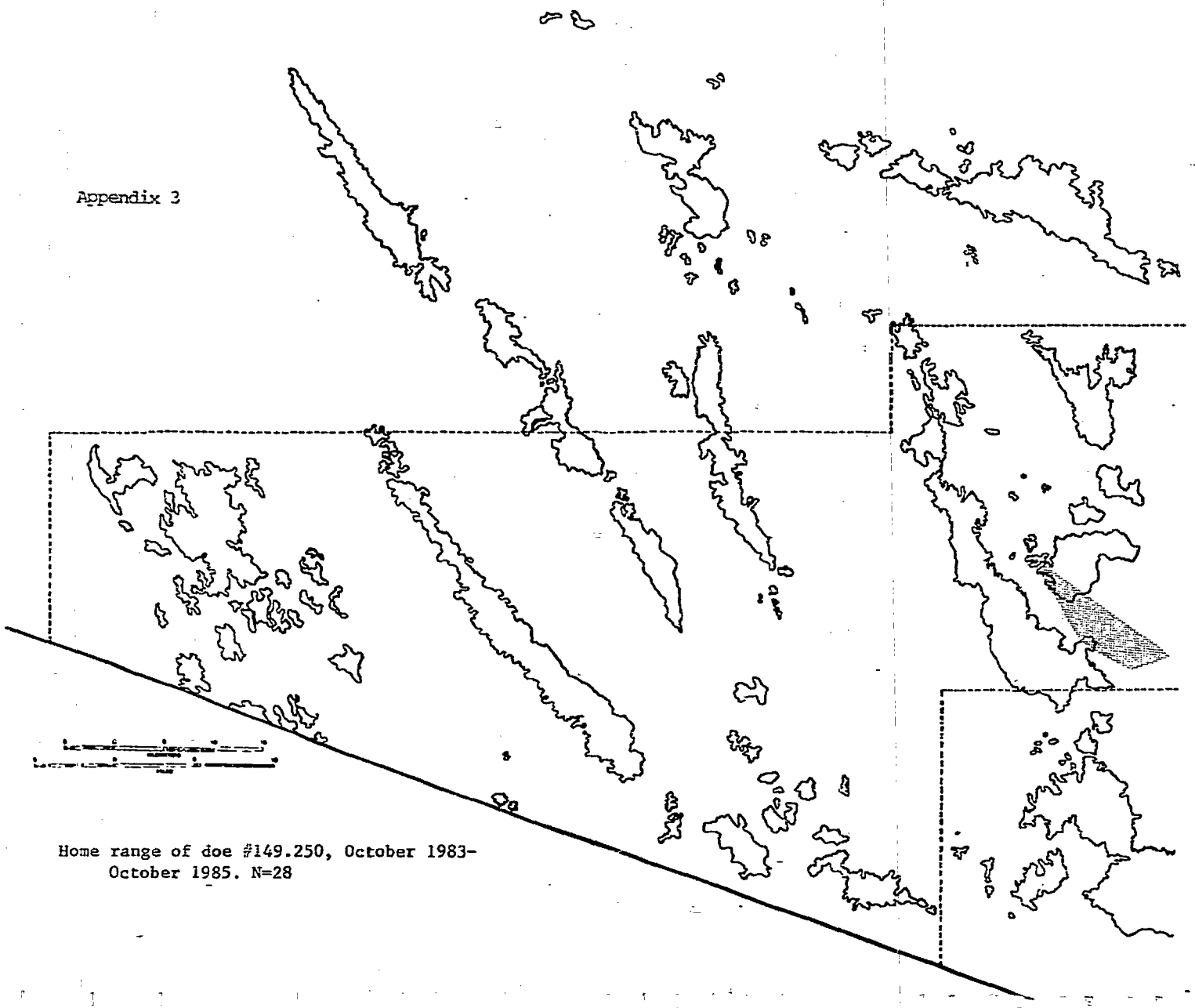
Home range of doe #149.081, October 1983–October 1985. N=48

Appendix 3



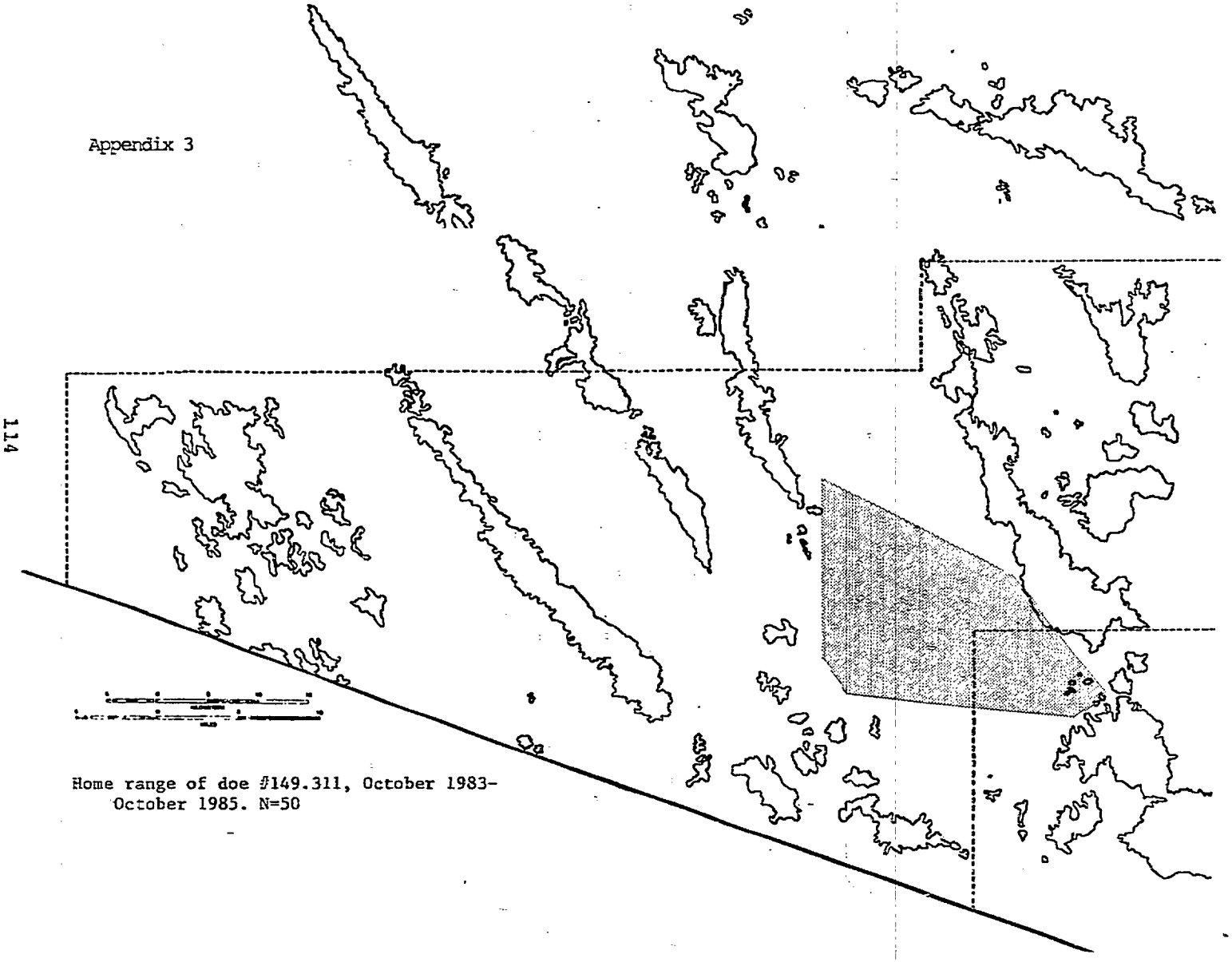
Home range of doe #149.290, October 1983-
October 1985. N=42

Appendix 3



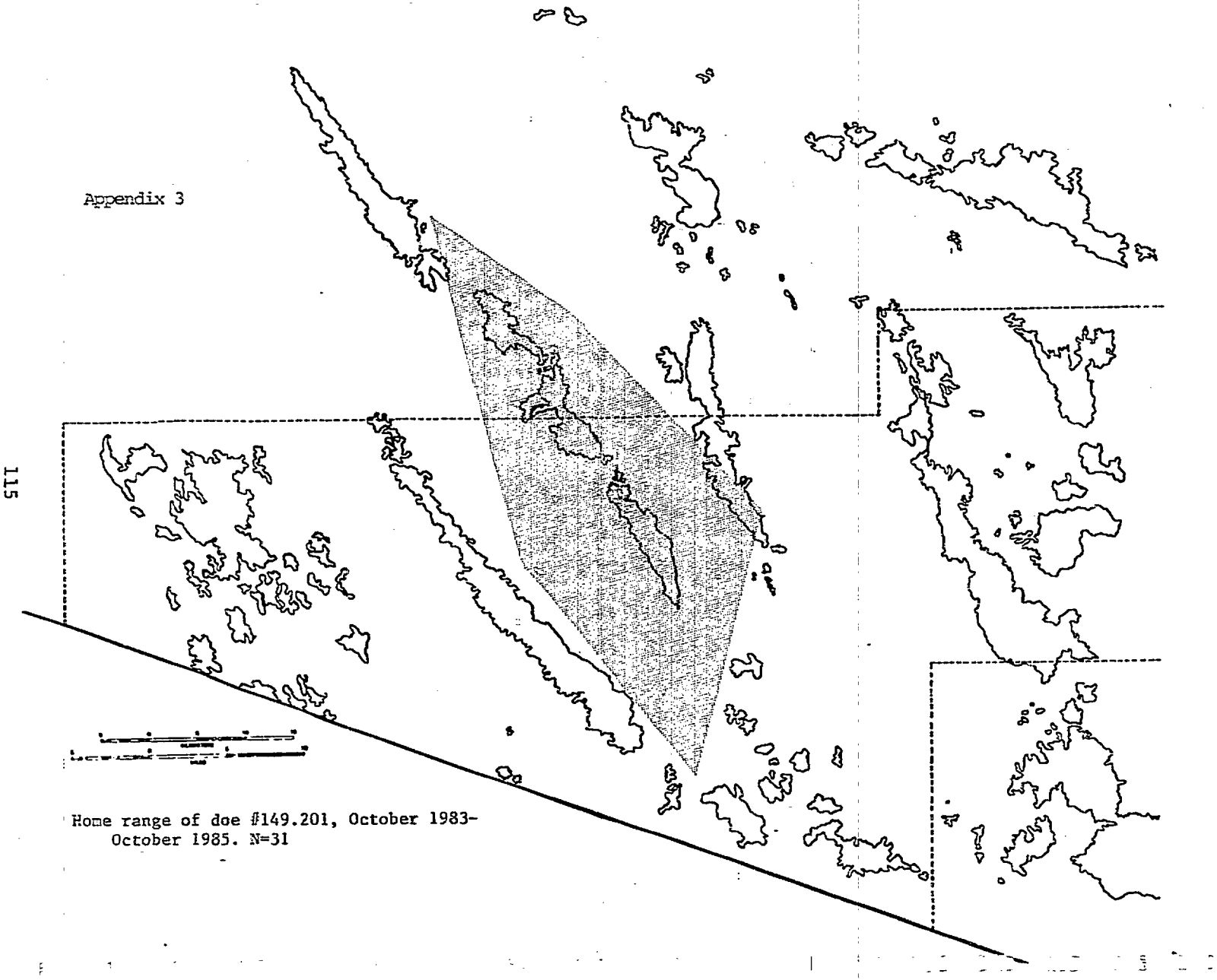
Home range of doe #149.250, October 1983-
October 1985. N=28

Appendix 3



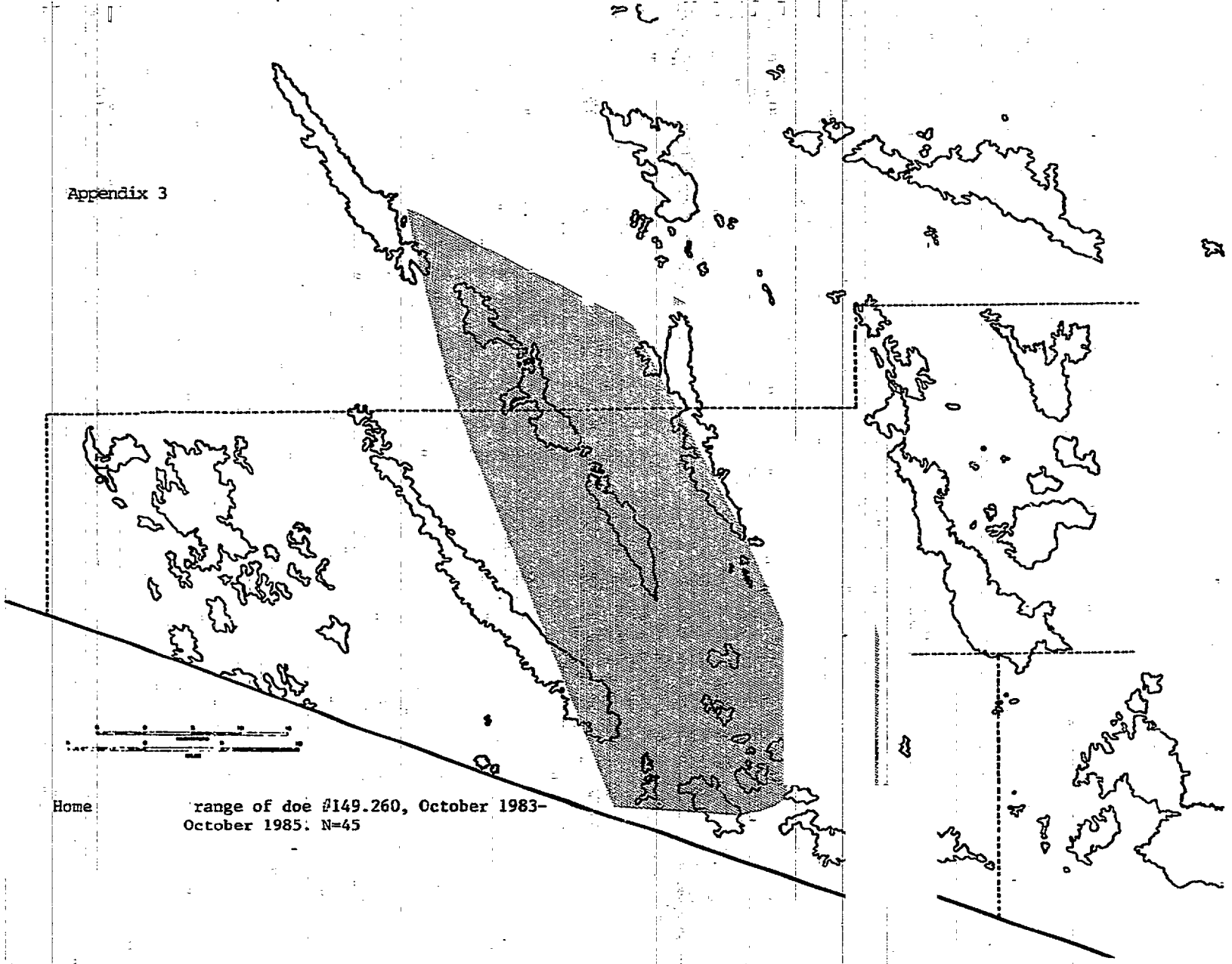
Home range of doe #149.311, October 1983-
October 1985. N=50

Appendix 3



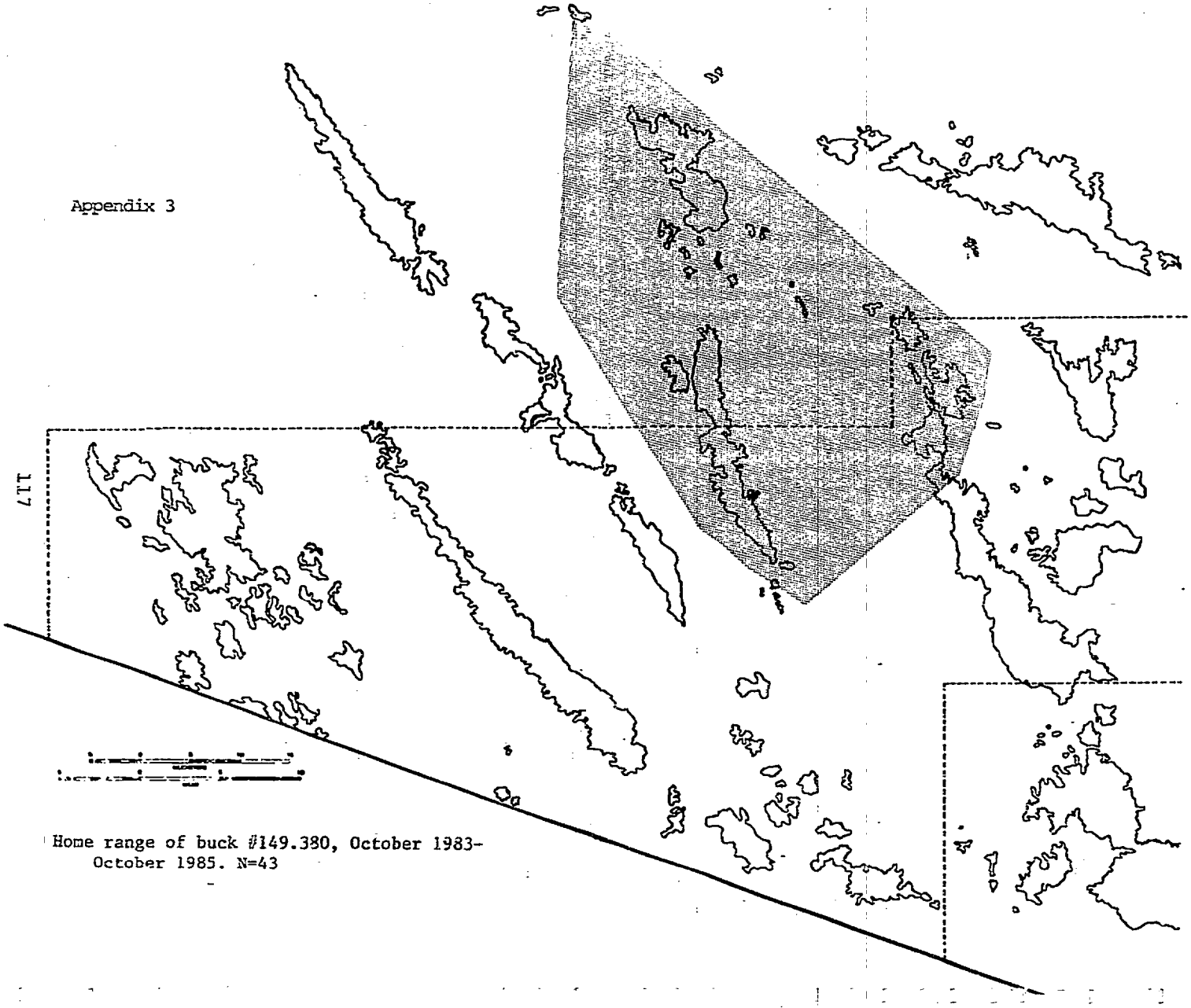
Home range of doe #149.201, October 1983-
October 1985. N=31

Appendix 3



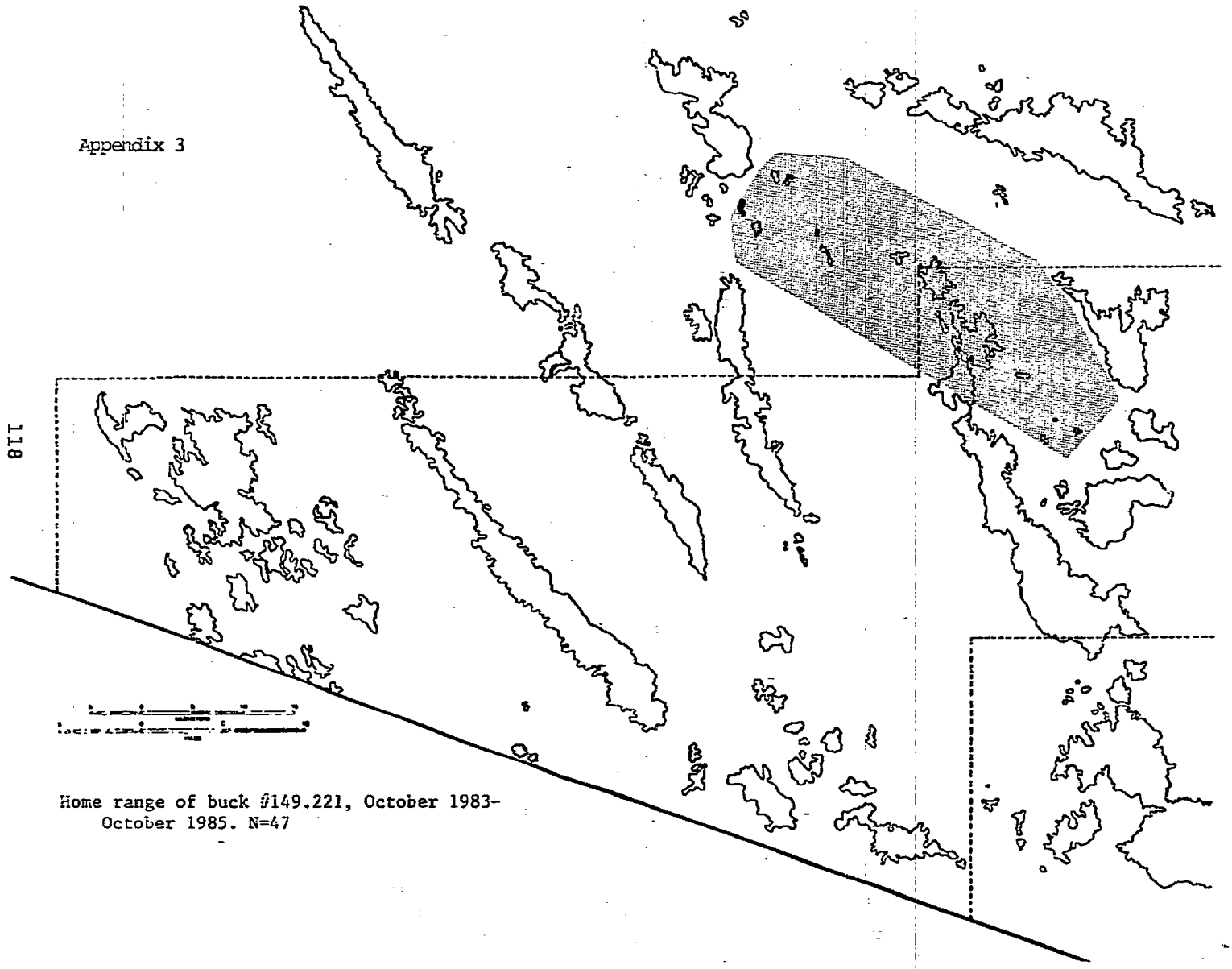
Home range of doe #149.260, October 1983-October 1985. N=45

Appendix 3



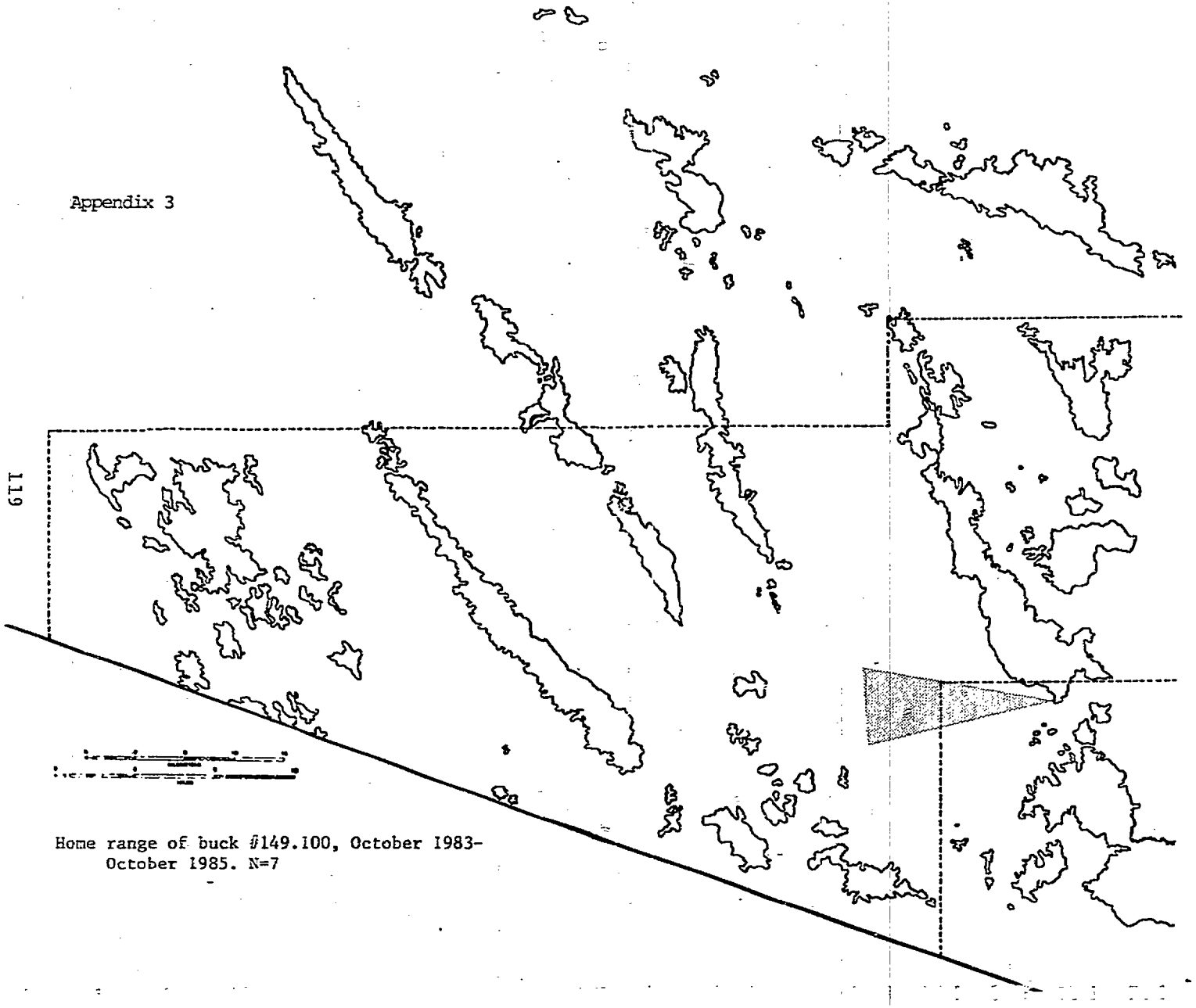
Home range of buck #149.380, October 1983-
October 1985. N=43

Appendix 3



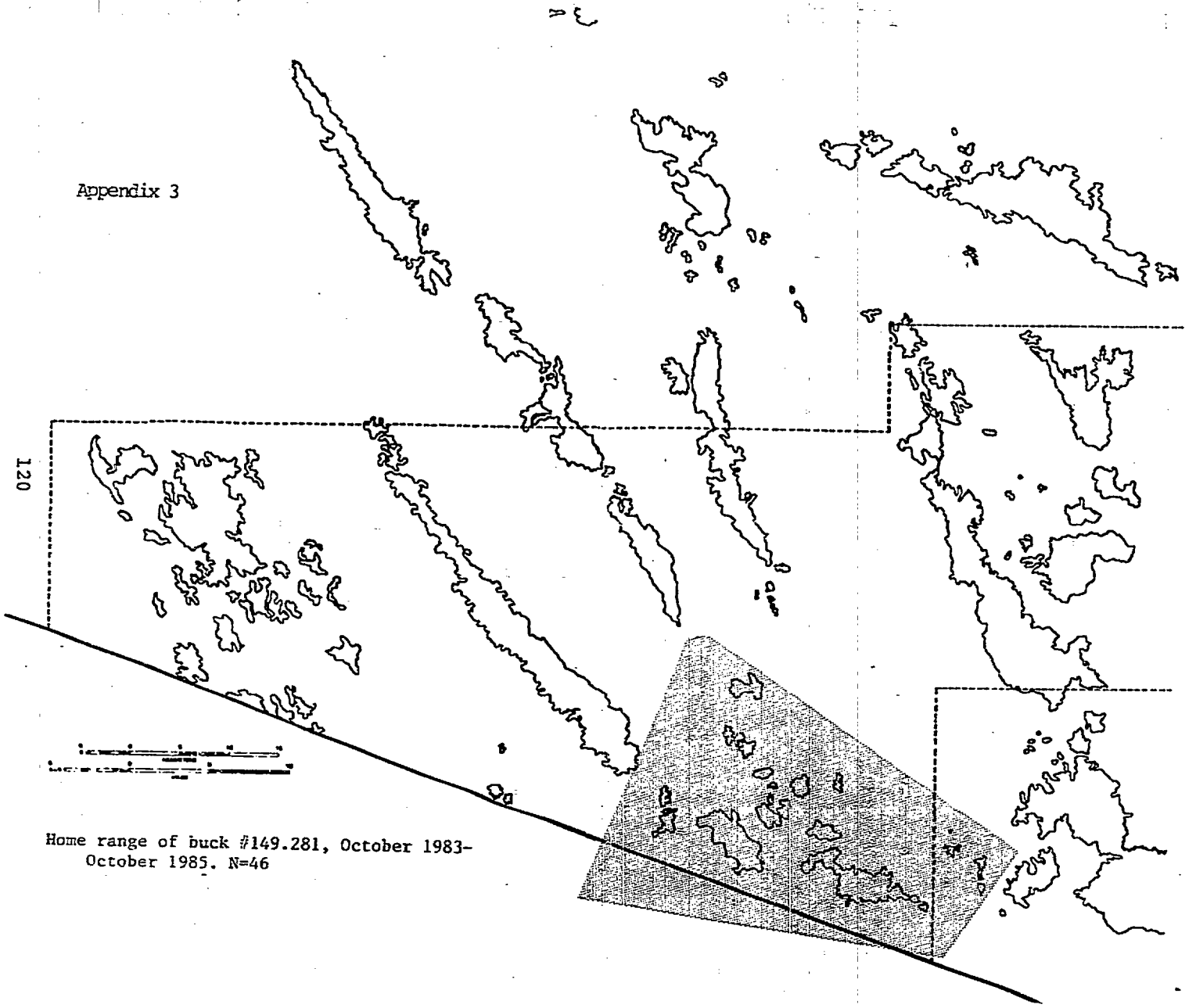
Home range of buck #149.221, October 1983-
October 1985. N=47

Appendix 3



Home range of buck #149.100, October 1983-
October 1985. N=7

Appendix 3



Home range of buck #149.281, October 1983-October 1985. N=46

Appendix 4. Mean distance between locations, mean days between locations and mean distance moved per day, by season for each collared Sonoran pronghorn antelope, October 1983 to October 1985. Periods of greater than 31 days between relocations were excluded.

Frequency #	Sex	Season*	N	Avg. Distance Between	SD	Avg. Days Between	SD	Avg. Distance/Day	SD
149.081	F	1	9	8.0	4.7	13	10.8	.54	20.1
		2	22	6.3	5.9	8	5.3	.89	.9
		3	12	9.6	8.2	9	4.9	1.08	.9
149.100	M	1	2	6.2	1.3	13	17.7	2.77	3.5
		2	1	1.97	0	7	0	.28	0
		3	1	3.77	0	14	0	.27	0
149.201	F	1	10	8.3	4.7	12	9.4	.58	.3
		2	21	6.9	9.1	11	6.8	.69	.9
		3	12	5.5	3.6	9	5.0	.63	.5
149.221	M	1	10	8.3	4.7	12	9.9	.58	.3
		2	21	6.9	9.1	11	6.8	.69	.9
		3	12	5.5	3.6	9	5.0	.63	.5
149.250	F	1	3	4.2	4.4	16	11.7	.54	.8
		2	10	3.1	3.3	12	7.5	.39	.5
		3	12	2.7	1.5	9	5.0	.31	.2
149.260	F	1	6	20.7	12.4	20	11.4	1.65	2.0
		2	24	7.2	4.9	12	7.3	.77	.7
		3	11	13.3	8.1	9	3.7	1.58	.9
149.281	M	1	8	3.9	2.6	12	8.7	.49	.4
		2	22	4.5	3.3	10	6.0	.58	.4
		3	12	3.4	3.0	10	5.0	.32	.2
149.290	F	1	2	5.7	3.3	17	16.3	.72	.9
		2	24	4.0	3.0	11	6.6	.47	.4
		3	12	2.7	1.5	9	5.0	.31	.2

Appendix 4. continued

Frequency #	Sex	Season*	N	Avg. Distance Between	SD	Avg. Days Between	SD	Avg. Distance/Day	SD
149.311	F	1	10	5.8	7.0	12	9.7	.86	1.6
		2	26	3.6	2.6	11	6.5	.42	.4
		3	11	6.8	4.5	10	5.0	.71	.4
149.380	M	1	7	9.6	5.7	12	10.7	2.03	3.5
		2	22	9.3	9.4	10	6.8	1.00	.9
		3	9	10.5	7.7	13	7.5	1.15	1.4

* 1 = Feb, Mar, Apr
2 = May, June, July, Aug, Sept
3 = Oct, Nov, Dec, Jan

Appendix 5. Location of vegetation transects conducted on CPNWR, LAFBGF, OPCNM and BLM, October 1983 to October 1985.

Transect #	Animal #	Date	UTM Coordinate	Vegetation Type
1	250/290	9-20-84	3-18.1Ex35-70.1N	111
2	250/290	9-20-84	3-16.5Ex35-71.7N	123
3	250/290	9-20-84	3-21.1Ex35-65.1N	121
4	250/290	9-20-84	3-24.5Ex35-65.9N	123
5	250/290	9-21-84	3-16.9Ex35-72.3N	111/123
6	250/290	10-21-84	3-16.3Ex35-72.5N	112
7	250	10-21-84	3-15.3Ex35-71.7N	123
8	250/290	10-22-84	3-16.7Ex35-69.1N	111
9	250	10-22-84	3-17.1Ex35-69.5N	111
10	250/290	10-21-84	3-16.7Ex35-72.7N	112
11	250/290	11-18-84	3-16.5Ex35-68.1N	121
12	250/290	10-21-84	3-15.1Ex35-72.9N	113
13	290	11-18-84	3-16-5Ex35-68.5N	121
18	250/290	10-12-84	3-17.1Ex35-70.1N	111
19	250/290	10-12-84	3-17.1Ex35-70.5N	111
20	250/290	10-12-84	3-17.5Ex35-70.3N	111
21	281	12-1-84	3-05.1Ex35-51.1N	111
22	221	2-15-86	3-05.3Ex35-50.7N	111
23	281	2-14-86	3-10.7Ex35-39.9N	122
24	281	2-14-86	3-05.3Ex35-47.5N	111
25	281	12-1-85	3-09.1Ex35-38.3N	111
27	281	12-1-85	3-04.9Ex35-50.1N	111
28	281	12-1-85	3-03.3Ex35-52.1N	111
29	281	12-1-85	3-05.5Ex35-51.1N	111
36	100	12-22-85	2-99.1Ex35-68.3N	111
37	100	12-22-85	3-01.1Ex35-65.1N	123
38	081	12-22-85	3-06.3Ex35-49.1N	111
39	081	12-22-85	2-99.1Ex35-68.3N	111
49	081	12-22-85	3-00.5Ex35-65.5N	111
54	081	12-22-85	2-92.7Ex35-86.9N	111
58	221	2-15-86	2-93.9Ex36-08.7N	111
61	221	12-21-85	3-12.3Ex35-91.3N	122
62	221	12-21-85	3-13.3Ex35-91.5N	122
65	221	2-15-86	2-88.3Ex36-06.1N	111
67	221	2-15-86	2-87.5Ex36-04.9N	111
68	221	2-15-86	2-95.1Ex36-01.7N	111
69	221	2-15-86	2-89.3Ex36-05.5N	111
70	221	2-15-86	2-88.5Ex36-08.5N	111
76	260	12-23-85	2-88.9Ex35-54.7N	112
78	260	12-23-85	2-84.9Ex35-53.9N	123
79	260	12-23-85	2-86.7Ex35-55.1N	123
80	260	12-23-85	2-89.9Ex35-55.3N	122
81	260	12-1-85	2-90.5Ex35-71.5N	111
84	260	2-13-86	2-78.7Ex35-67.9N	111
86	260	2-13-86	2-78.7Ex35-62.7N	111
88	260	2-13-86	2-78.9Ex35-63.5N	111
89	260	2-13-86	2-78.3Ex35-65.1N	111
112	311	12-21-85	3-11.7Ex35-06.3N	112
113	311	12-21-85	3-10.3Ex35-60.7N	112

Appendix 5. continued

Transect #	Animal #	Date	UTM Coordinate	Vegetation Type
115	311	12-22-85	3-00.3Ex35-63.9N	111
126	380	2-15-86	2-86.1Ex36-03.7N	111
135	380	2-15-86	3-07.1Ex35-99.7N	122
154	311	12-22-85	2-98.1Ex35-62.1N	111
156	311	12-22-85	3-01.7Ex35-63.9N	111
158	311	12-22-85	3-01.9Ex35-65.3N	111
160	081	12-22-85	3-00.3Ex35-65.9N	111
161	311	12-22-85	2-99.9Ex35-65.5N	111
165	281	12-1-85	3-09.1Ex35-48.3N	111
166	281	2-14-86	3-05.5Ex35-48.5N	111
167	281	2-14-86	3-06.5Ex35-47.1N	111
169	281	12-1-85	3-06.7Ex35-49.3N	112
170	281	12-1-85	3-05.1Ex35-50.5N	111
172	281	12-1-85	3-05.7Ex35-49.1N	112
173	281	2-14-86	3-06.9Ex35-46.9N	111
174	281	2-14-86	3-07.5Ex35-47.7N	112
175	281	12-1-85	3-05.5Ex35-50.7N	111
182	081	12-22-85	3-01.7Ex35-65.7N	111
183	250/290	11-30-85	3-15.3Ex35-73.1N	112
184	250/290	11-30-85	3-17.1Ex35-70.5N	111
185	250/290	2-12-86	3-16.3Ex35-69.5N	122
187	290	2-12-86	3-16.3Ex35-68.3N	122
188	250/290	11-30-85	3-14.9Ex35-72.9N	112
189	250/290	2-12-86	3-14.9Ex35-74.7N	112/122
190	250/290	11-30-85	3-14.9Ex35-72.5N	112
193	260	2-13-86	2-72.9Ex35-70.7N	111
196	281	12-1-85	3-05.3Ex35-52.5N	111
197	281	12-1-85	3-03.9Ex35-52.5N	111
198	311	12-21-85	3-12.1Ex35-59.7N	112
199	311	2-12-86	3-13.1Ex35-56.5N	122
200	311	2-12-86	3-13.7Ex35-56.5N	122
203	380	2-15-86	2-87.3Ex36-07.3N	112
208	081	12-22-85	3-02.3Ex35-75.9N	111
210	081	12-22-85	2-98.7Ex35-69.5N	111
211	081	12-22-85	3-01.1Ex35-66.3N	111
212	081	12-22-85	3-01.3Ex35-65.1N	111
215	221	2-15-86	2-86.1Ex36-07.9N	112
219	260	2-13-86	2-81.3Ex35-60.5N	111
220	281	12-1-85	3-08.3Ex35-49.3N	111
222	281	12-1-85	3-06.1Ex35-49.5N	112
224	311	2-12-86	3-14.1Ex35-57.1N	112
227	260	2-13-86	2-84.9Ex35-55.5N	111
228	311	2-12-86	3-13.5Ex35-56.5N	122
229	311	2-12-86	3-13.1Ex35-57.1N	122
231	281	12-1-85	3-08.6Ex35-48.6N	111
232	281	12-1-85	3-09.1Ex35-49.7N	111
236	290	11-30-85	3-19.9Ex35-67.5N	112
238	221	2-15-86	2-90.9Ex36-06.7N	111
243	311	2-12-86	3-13.5Ex35-57.5N	122
245	281	2-14-86	3-07.7Ex35-46.9N	112
246	290	11-30-85	3-05-1Ex35-42.7N	112
247	260	12-23-85	2-88.7Ex35-54.7N	112

Appendix 5. continued

Transect #	Animal #	Date	UTM Coordinate	Vegetation Type
248	221	12-21-85	3-14.9Ex35-89.5N	122
249	221	12-21-85	3-13.7Ex35-90.9N	122
250	221	12-21-85	3-12.5Ex35-90.3N	122
251	390	11-30-85	3-04.1Ex35-84.9N	112
252	380	11-30-85	3-08.5Ex35-77.1N	112
261	260	12-23-85	2-86.7Ex35-54.1N	112
264	281	2-14-86	3-08.7Ex35-41.5N	122
265	290	11-30-85	3-14.9Ex35-70.5N	111
266	290	2-12-86	3-15.9Ex35-69.3N	122
267	311	2-12-86	3-13.1Ex35-57.1N	122
268	311	12-21-85	3-12.1Ex35-55.9N	112
269	380	11-30-85	3-04.1Ex35-85.7N	112
274	081	12-22-85	2-90.7Ex35-88.3N	111
275	221	11-30-85	3-12.7Ex35-78.9N	112
276	221	11-30-85	3-13.1Ex35-79.9N	112
277	221	11-30-85	3-11.1Ex35-80.3N	112
278	221	2-15-86	2-88.1Ex36-09.7N	111
279	260	2-13-86	2-79.5Ex35-60.7N	111
280	260	2-13.86	2-82.5Ex35-56.7N	111
281	260	2-16-86	2-80.3Ex35-61.1N	112
282	260	12-23-85	2-86.5Ex35-54.7N	112
283	260	12-23-85	2-86.5Ex35-54.1N	112
285	281	12-1-85	3-09.1Ex35-49.3N	111
286	281	12-1-85	3-05.7Ex35-48.3N	111
287	281	12-1-85	3-08.5Ex35-49.3N	111
289	290	2-12-86	3-14.7Ex35-68.9N	122
291	290	11-30-85	3-18.1Ex35-70.1N	111
292	311	12-22-85	3-12.5Ex35-59.7N	112
294	311	12-22-85	3-01.9Ex35-62.1N	111
296	380	11-30-85	3-05.1Ex35-86.3N	112
298	380	12-22-85	2-93.9Ex35-86.7N	111
301	221	2-15-86	2-91.3Ex36-07.3N	111
311	260	2-13-86	2-70.7Ex35-73.3N	111
312	281	2-14-86	3-08.1Ex35-45.9N	111

Appendix 6. Four letter code, scientific name, and common name for vegetation identified on the Sonoran pronghorn study live intercept transects.

Code	Scientific Name	Common Name
ACGR	Acacia greggii	Catclaw acacia
AMAM	Ambrosia ambrosioides	Canyon ragweed
AMDE	Ambrosia deltoidea	Triangle-leaf bursage
AMDU	Ambrosia dumosa	White bursage
BASA	Baccharis sarothroides	Desert broom
BEJU	Bebbia juncea	Desert rush
CAER	Calliandra eriophylla	False mesquite
CEFL	Cercidium floridum	Blue paloverde
CEGI	Cereus giganteus	Saguaro
CEMI	Cercidium microphyllum	Littleleaf paloverde
CETH	Cereus thurberi	Organ pipe
COGL	Condalia globosa	Gray-thorn
ECEN	Echinocereus engelmannii	Engelmann hedgehog cactus
ENFA	Encelia farinosa	White brittlebrush
FERO	Ferocactus sp.	Barrel cactus
FOSP	Fouquiera splendens	Ocotillo
GUMI	Gutierrezia microcephala	Three-leaved snakeweed
HIRI	Hilaria rigida	Big galleta
HYME	Hymenoclea sp.	Cheesebrush
JACU	Jatropha cuneata	Sangre-de-drago
KRGR	Krameria grayi	White ratany
LATR	Larrea tridentata	Creosotebush
LEGO	Lesquerella gordoni	Bladder-pod
LYCI	Lycium sp.	Wolfberry
NEGL	Nemacladus glanduliferus	Thread plant
OLTE	Olneya tesota	Ironwood
OPAC	Opuntia acanthocarpa	Buckhorn cholla
OPBI	Opuntia bigelovii	Teddy bear cholla
OPFU	Opuntia fulgida	Jumping cholla
OPLE	Opuntia leptocaulis	Desert Christmas cactus
OPRA	Opuntia ramosissima	Diamond cholla
OPUN	Opuntia sp.	Cholla
OPVE	Opuntia versicolor	Staghorn cholla
PRJU	Prosopis juliflora	Mesquite
SPAM	Sphaeralcea ambigua	Desert globe mallow
ZIOB	Ziziphus obtusifolia	Graythorn

Appendix 7. Density estimates for perennial vegetation derived from line-intercept data collected at actual pronghorn locations

Code	111[1] n=71	112[2] n=34	113[3] n=1	121[4] n=2	122[5] n=19	123[6] n=2	111/112[7] n=1	111/123[8] n=4	112/122[9] n=1	121/123[10] n=1	122/123[11] n=1	ALL HABITATS
AMDE	004.91	012.93	039.01	020.92	009.78	005.75		001.04	024.69		005.92	008.10
LATR	004.84	005.24	002.93	003.30	005.60	005.25	009.41	008.89	001.50		005.01	005.10
CPLE	000.13	000.02			000.16							000.09
KRGR	000.37	000.71			001.78		000.67	000.21				000.63
CEMI	000.00	000.05			000.16							000.04
SPAM	004.25	000.01			000.91							002.35
AMDU	000.97	001.39			003.10		008.13	012.79			004.60	001.75
LYCI	000.08	000.15			000.38	002.93		000.37				000.19
OPUN		000.39			000.14							000.12
FOSP	000.01	000.28	000.40	000.21	000.26	000.24	000.53					000.13
ACGR					000.07							000.01
OLTE	000.01	000.02			000.02							000.01
GUMI					000.09							000.01
NEGL	002.54	016.47			000.24							005.47
FERO	000.05											000.02
OPRA	000.32	000.64			000.16	000.83						000.36
OPBI		000.30			000.56							000.15
CEGI					000.04	001.25			001.00			000.03
COGL					000.08							000.01
ZIOB					000.01							000.00
CETH					000.03							000.00
ECEN					000.53							000.07
CEFL		000.00		000.10		000.11		000.03				000.00
PRJU	000.01	000.16				000.34		000.13		004.50		000.08
OPVE		000.48	003.33	000.38								000.15
AMAM		000.04								001.25		000.02
OPFU	000.06	000.27		000.42								000.11
LEGO				000.42								000.01
OPAC		000.10		002.54	000.09							000.08
CAER		000.06										000.01
HIRI	000.14	000.07			000.11	004.26	002.50					000.19
ENFA		000.03										000.01
HYME		000.01			000.07	002.41					000.42	000.05

Appendix 7. continued

Code	111[1] n=71	112[2] n=34	113[3] n=1	121[4] n=2	122[5] n=19	123[6] n=2	111/112[7] n=1	111/123[8] n=4	112/122[9] n=1	121/123[10] n=1	122/123[11] n=1	ALL HABITATS
JACU		000.12										000.03
BEJU				001.00								000.14
BASA					000.31							000.00
TOTAL	018.69	039.95	045.68	028.29	025.34	020.67	021.24	023.45	027.19	005.75	015.95	025.55

[1]Creosote-bursage

[2]Creosote-ocotillo

[3]Creosote-paloverde

[4]Paloverde-saguaro

[5]Paloverde-ironweed

[6]Paloverde-mesquite

[7]Creosote-bursage/creosote-ocotillo interspersion

[8]Creosote-bursage/paloverde-mesquite interspersion

[9]Creosote-ocotillo/paloverde-ironwood interspersion

[10]Paloverde-saguaro/paloverde-mesquite interspersion

[11]Paloverde-ironwood/paloverde-mesquite interspersion

Appendix 8. Percent cover estimates for perennial vegetation derived from line-intercept data collected at actual pronghorn locations

Code	111[1] n=71	112[2] n=34	113[3] n=1	121[4] n=2	122[5] n=19	123[6] n=2	111/112[7] n=1	111/123[8] n=4	112/122[9] n=1	121/123[10] n=1	122/123[11] n=1	ALL HABITATS
AMDE	2.130	5.179	14.200	8.350	5.132	3.100		0.350	9.000		2.000	3.4875
LATR	9.301	8.171	8.600	5.850	10.642	9.100	10.500	19.950	1.100		9.400	9.4096
OPLE	0.025	0.021			0.042							0.0243
KRGR	0.286	0.524			1.063		0.900	0.175				0.4404
CEMI	0.024	0.274			0.663							0.1735
SPAM	0.062	0.032			0.095							0.0537
AMDU	0.290	0.526			1.205		3.300	1.425			1.900	0.5316
LYCI	0.041	0.103			0.632	5.000		0.350				0.2191
OPUN		0.009			0.179							0.0272
FOSP	0.015	0.197	0.100	0.700	0.605	0.100	0.600					0.1588
ACGR					0.100							0.0140
CLTE	0.092	0.071			0.300							0.1074
GUMI					0.142							0.0199
NEGL	0.023	0.165			0.021							0.0559
FERO	0.004											0.0022
OPRA	0.104	0.232			0.074	0.150						0.1250
OPBI		0.029			0.037							0.0125
CRGI					0.053	0.200			1.300			0.0199
COGL					0.016							0.0022
ZIOB					0.053							0.0074
CETH					0.032							0.0044
ECEN					0.005							0.0007
CEFL		0.059		0.050		1.200		1.750				0.0846
PRJU	0.061	0.082				6.350		2.650		31.500		0.4551
OPVE		0.015	0.100	0.350								0.0096
AMAM		0.041								0.200		0.0118
OPFU	0.008	0.235		0.050								0.0640
LEGO				0.450								0.0066
OPAC		0.012		1.450	0.016							0.0265
CAER		0.006										0.0015
HIRI	0.075	0.026			0.005	3.100	0.200					0.0934
ENFA		0.006										0.0015
HYME		0.059			0.011	1.600					1.400	0.0500

Appendix 8. continued

Code	111[1] n=71	112[2] n=34	113[3] n=1	121[4] n=2	122[5] n=19	123[6] n=2	111/112[7] n=1	111/123[8] n=4	112/122[9] n=1	121/123[10] n=1	122/123[11] n=1	ALL HABITATS
JACU		0.144										0.0360
BEJU					0.332							0.0463
BASA						2.100						0.0309
TOTAL	12.541	16.218	23.000	17.250	21.453	32.000	15.500	26.650	11.400	31.700	14.700	15.8147

[1]Creosote-bursage

[2]Creosote-ocotillo

[3]Creosote-paloverde

[4]Paloverde-saguaro

[5]Paloverde-ironweed

[6]Paloverde-mesquite

[7]Creosote-bursage/creosote-ocotillo interspersion

[8]Creosote-bursage/paloverde-mesquite interspersion

[9]Creosote-ocotillo/paloverde-ironwood interspersion

[10]Paloverde-saguaro/paloverde-mesquite interspersion

[11]Paloverde-ironwood/paloverde-mesquite interspersion

Appendix 9. Rain gauge readings (in millemeters), July 1984 to September 1985, on CPNWR, OPCNM and LAFBGR.

#	Date 7/84	8/84	9/84	10/84	11/84	12/84	1/85	2/85	3/85	4/85	5/85	6/85	7/85	8/85	9/85
1-06	10.2	25.4	113.0	19.1	0	6.4		38.1			**	0			
2-07	36.8	27.9	72.4	22.9	0	8.9		88.9			1.3		0		
3-35		27.9	35.6	10.2	2.5	7.6		72.4			2.5		0		
4-28		82.6		44.5											
5-31		50.8		62.2											
6-30		50.8		55.9											
7-32															
8-33															
9-															
10-35					69.9	11.4									
11-01		52.1			44.5	11.4					5.72				
12-02		50.8			82.6	19.1					76.2				
13-03		68.6			91.4	7.6					88.9				
14-															
15-20		69.9	129.6	3.8	0	12.7		38.1							
16-18		91.4	45.7	19.1	2.5	25.4		38.1			6.4		0		
17-17		120.7	*	17.8	0	22.9		38.1			14.0		0		
18-09	6.4	80.0	63.5	27.9	1.3	22.9		85.1			15.2		2.4		81.3
19-16		106.7	22.9	31.8	0	19.1		90.2					5.2		34.3
20-08	3.8	94.0	*	45.7	2.5	41.9		40.7			17.8		0		
21-23		63.5	127.0	22.9	1.3									128.3	
22-24		47.0	91.4	12.7	0										
23-25		38.1	57.2		24.1										
24-26		68.6	121.9		15.2										
25-29															
26-27		69.9	109.2												
27-14	12.7	38.1	88.9	8.9	0	10.2		31.8			1.3		6.4	11.4	96.5
28-05	8.9	48.3	88.9	17.8	0	10.2		31.8			2.5		3.8		
29-13	29.2	90.8	77.5	19.05	0	16.5		28.0			2.5		6.4		
30-12	36.8	90.2	67.3	29.2	3.8	12.7		33.0			6.4		3.8		
31-36		72.4	94.0	25.4	1.3	11.4									

* = On Ground
** = Stolen

Appendix 9. continued

#	Date														
	7/84	8/84	9/84	10/84	11/84	12/84	1/85	2/85	3/85	4/85	5/85	6/85	7/85	8/85	9/85
32-11	19.1	78.7	57.2	31.8	0	17.8		34.3					*		
33-15	1.3	77.5	48.3	22.9	1.3	34.3		35.6				0	3.8		20.8
34-10	1.0	99.1	78.7	31.8	2.5	22.9		31.8				8.9	5.1	26.7	
35-04	8.9	101.6	83.8	38.1	0	25.4		31.8					0		12.2
36-38				22.9	1.3	15.2		33.0				8.9	3.8		
37-22		69.9			54.6	8.9									
38-21		67.3	63.5	11.43	0	21.6		38.1							
39-37				10.2	12.7	8.9		38.1							
40-19		101.6	49.5	14.0	0	15.2		38.1							

* = On Ground